ECONOMETRICA

JOURNAL OF THE ECONOMETRIC SOCIETY

An International Society for the Advancement of Economic Theory in its Relation to Statistics and Mathematics

VOLUME 61

1993

INDEX

ARTICLES

NOTES AND COMMENTS

ANNOUNCEMENTS AND NEWS NOTES

Econometrica, Vol. 61, No. 2 (March, 1993), 325–351

REPUTATION AND EQUILIBRIUM CHARACTERIZATION IN REPEATED GAMES WITH CONFLICTING INTERESTS

BY KLAUS M. SCHMIDT[1]

A two-person game is of *conflicting interests* if the strategy to which player one would most like to commit herself holds player two down to his minimax payoff. Suppose there is a positive prior probability that player one is a "commitment type" who will always play this strategy. Then player one will get at least her commitment payoff in any Nash equilibrium of the repeated game if her discount factor approaches one. This result is robust against further perturbations of the informational structure and in striking contrast to the message of the Folk Theorem for games with incomplete information.

KEYWORDS: Commitment, Folk Theorem, repeated games, reputation.

1. INTRODUCTION

CONSIDER A REPEATED RELATIONSHIP between two long-run players, one of whom has some private information about her type. A common intuition is that the informed player may take advantage of the uncertainty of her opponent and enforce an outcome more favorable to her than that which she would have obtained under complete information. This intuition has been called "reputation effect" and has found considerable attention in the literature. The purpose of this paper is to formalize this intuition in a general model of repeated games with "conflicting interests" and to show that the effect is robust against perturbations of the informational structure of the game.

The first formalization of reputation effects in games with complete information have been developed by Kreps and Wilson (1982) and Milgrom and Roberts (1982). They have shown that a small amount of incomplete information can be sufficient to overcome Selten's (1978) chain-store paradox. An incumbent monopolist who faces a sequence of potential entrants may deter entry by maintaining a reputation for "toughness" if there is a small prior probability that she is a "tough" type who prefers a price war to acquiescence. Recently, this result has been generalized and considerably strengthened by Fudenberg and Levine (1989, 1992). They consider the class of all repeated games in which a long-run player faces a sequence of short-run opponents, each of whom plays only once but observes all previous play. They show that if there is a positive prior probability of a "commitment type," who always plays the strategy to which player one would most like to commit herself, and if player

[1] This paper is based on Chapter 3 of my Ph.D. thesis which was completed within the European Doctoral Programme at Bonn University. Financial support by Deutsche Forschungsgemeinschaft, SFB 303 at Bonn University, is gratefully acknowledged. I would like to thank David Canning, In-Koo Cho, Eric Maskin, Benny Moldovanu, Georg Nöldeke, Ariel Rubinstein, Avner Shaked, Joel Sobel, Monika Schnitzer, Eric van Damme, and in particular Drew Fudenberg, a co-editor, and an anonymous referee for many helpful comments and discussions. I am also grateful for comments by seminar participants at Berkeley, Bonn, Boston, Chicago, Harvard, Mannheim, MIT, Northwestern, Penn, Princeton, San Diego, Tilburg, and Vienna Universities.

one is sufficiently patient, then she can enforce at least her commitment payoff in any Nash equilibrium, i.e. she will get at least what she would have obtained if she could have committed herself publicly to this strategy. This result is very powerful, because (i) it gives a tight lower bound for player one's payoff in all Nash equilibria, (ii) it holds for finitely and infinitely repeated games, and (iii) it is robust against further perturbations of the informational structure, i.e. it is independent of what other types may exist with positive probability. However, Fudenberg and Levine's analysis is restricted to games where a long-run player faces a sequence of short-run opponents. Our paper provides a generalization and qualification of their results for the two long-run player case. We show that a necessary and sufficient condition for this generalization to hold is that the game is of conflicting interests.

To make this more precise, consider a repeated game in which player one would like to commit herself to take an action a_1^*, called her "commitment action," in every period. If player two responds optimally to a_1^*, player one gets her "commitment payoff." Assume that the game is of "conflicting interests" in the sense that playing a_1^* holds player two down to his minimax payoff. Now suppose that the informational structure of this game is perturbed such that player one may be one of several possible "types." Consider a type for whom it is a dominant strategy in the repeated game always to play a_1^* and call her the "commitment type." Our main theorem says that if the commitment type has any arbitrarily small but positive prior probability and if player one's discount factor goes to 1, then her payoff in any Nash equilibrium is bounded below by her commitment payoff. This result is independent of the nature of any other possible types and their respective probabilities. We generalize the theorem to the case of two-sided uncertainty. If the game is not of "conflicting interests" this lower bound does not apply. However, we show that our result may still impose some restriction on the set of equilibrium payoffs.

The main theorem highlights the importance of the relative patience of the two players. Player one has to be sufficiently patient as compared to player two, i.e. for any given discount factor $\delta_2 < 1$ there exists a $\underline{\delta}_1(\delta_2) < 1$ such that player one can enforce his commitment payoff in all Nash equilibria if his discount factor satisfies $\delta_1 > \underline{\delta}_1(\delta_2)$. The importance of the relative patience of the two players is most intuitive in the case of a completely symmetric game with two-sided uncertainty. If this game has conflicting interests, then it is clearly not possible that both players get their most preferred outcomes at the same time. However, if one of them is sufficiently more patient (or if the prior probability that she is the commitment type is sufficiently higher) then the reputation effect works to her advantage.

In the limit (as δ_1 approaches 1) our result gives a tight prediction of player one's average payoff in any Nash equilibrium—which seems to be in striking contrast to the message of the Folk Theorem for repeated games with incomplete information. Fudenberg and Maskin (1986) have shown that any feasible payoff vector, which gives each player at least his minimax payoff, can be sustained as an equilibrium outcome if the game is perturbed in the right way.

They assume that with some small probability ε each player may be one (and only one) "crazy" type. This crazy type follows a strategy which is tailored to the payoff vector to be sustained as an equilibrium outcome. We follow Fudenberg and Maskin in assuming that one particular type (in our case the "commitment" type) has positive probability. But our approach differs in that we allow for the possibility of arbitrary other types—including the "crazy" types considered by Fudenberg and Maskin. Our result shows that no matter what types may possibly be drawn by nature and how likely they are to occur, if the "commitment type" is present, if player one is sufficiently patient, and if the game has "conflicting interests," then the commitment type will dominate the play and player one can guarantee herself the commitment payoff in any Nash equilibrium. Thus, in games with conflicting interests the Folk Theorem is not "robust" against further perturbations of the informational structure. If we allow for the possibility of a commitment type of player one, then, as player one's discount factor approaches 1, all equilibria which give her less than her commitment payoff disappear. We discuss the relation of our results to the Folk Theorem more extensively in Section 4.3.

A complementary analysis to ours is Aumann and Sorin (1989). For a different class of repeated games, coordination games with "common interests," they obtain a similar result. However, they have to restrict the possible perturbations to types who act like automata with bounded recall. They show that if all strategies of recall zero exist with positive probability, then all pure strategy equilibria will be close to the cooperative outcome. In contrast to Aumann and Sorin we allow for any perturbation of player one's payoff function and for mixed strategy equilibria. Games of "common" and of "conflicting" interests are two polar cases. We will discuss them in more detail in Section 5.

Finally, in a recent paper Cripps and Thomas (1991) characterize the set of Nash equilibria of infinitely repeated games with one-sided incomplete information in which players maximize the limit of the mean of their undiscounted payoffs. Following a different method pioneered by Hart (1985) they also find that in games of conflicting interests the informed player can enforce her commitment payoff if there is a small prior probability of a commitment type. Since there is no discounting, their result seems to indicate that the relative patience is not that important after all. However, as we will show in Section 4, this interpretation is misleading.

The rest of the paper is organized as follows. In the next section we introduce the model following closely Fudenberg and Levine (1989), and we briefly summarize their main results. Then we give a counterexample showing that their theorem cannot carry over to all repeated games with two long-run players. This gives some intuition on how this class has to be restricted. Section 4 contains our main results. There we generalize Fudenberg and Levine's (1989) theorem to the two long-run player case, and we show that the restriction to games with "conflicting interests" is a necessary condition for this generalization to hold. Furthermore we extend the analysis to the case of two-sided incomplete information. In Section 5 we give several examples which demonstrate how restrictive the "conflicting interests" condition is. We also show that even if the game is not of conflicting interests, our results may still be useful to restrict the set of equilibrium outcomes. Section 6 concludes and briefly outlines several extensions of the model.

2. DESCRIPTION OF THE GAME

In most of the paper we consider the following very simple model of a repeated game which is an adaptation of Fudenberg and Levine (1989) and Fudenberg, Kreps, and Maskin (1990) to the two long-run player case. The two players are called "one" (she) and "two" (he). In every period they move simultaneously and choose an action a_i out of their respective action sets A_i, $i \in \{1,2\}$. Here we will assume that the A_i are finite sets.[2] As a point of reference consider the unperturbed game (with complete information) first. Let $g_i(a_1, a_2)$ denote the payoff function of player i in the unperturbed stage game g depending on the actions taken by both players. Let $\mathscr{A}_i$ denote the set of all mixed strategies α_i of player i and (in an abuse of notation) $g_i(\alpha_1, \alpha_2)$ the expected stage game payoffs.

The T-fold repetition of the stage game g is denoted by G^T, where T may be finite or infinite. We will deal in most of the paper with the infinite horizon case but all of the results carry over immediately to finitely repeated games if T is large enough. In the repeated game the overall payoff for player i from period t onwards (and including period t) is given by

$$(1) \qquad V_i^t = \sum_{\tau=t}^{\infty} \delta_i^{\tau-t} g_i^\tau,$$

where δ_i denotes her (his) discount factor ($0 \leqslant \delta_i < 1$). Our results are stated in terms of average discounted payoffs v_i, where

$$(2) \qquad v_i = (1-\delta_i) \cdot V_i^1 = (1-\delta_1) \cdot \sum_{\tau=1}^{\infty} \delta_1^{\tau-1} g_i^\tau .$$

After each period both players observe the actions that have been taken. They have perfect recall and can condition their play on the entire past history of the game. Let h^t be a specific history of the repeated game out of the set $H^t = (A_1 \times A_2)^t$ of all possible histories up to and including period t. A pure strategy s_i for player i in the repeated game is a sequence of maps s_i^t: $H^{t-1} \to A_i$. Correspondingly, let $\sigma_i = (\sigma_i^1, \sigma_i^2, \cdots)$ denote a mixed (behavioral) strategy of player i, where σ_i^t: $H^{t-1} \to \mathscr{A}_i$. For notational convenience the dependence on history is suppressed if there is no ambiguity. The set of all pure (mixed) strategies is denoted by S_i (Σ_i respectively).

[2] See Section 6 for the extension to extensive form stage games, continuous strategy spaces, and more than two players.

Let $B: \mathscr{A}_1 \mapsto \mathscr{A}_2$ be the best response correspondence of player two in the stage game and define[3]

$$(3) \qquad a_1^* = \underset{a_1 \in A_1}{\operatorname{argmax}} \min_{\alpha_2 \in B(a_1)} g_1(a_1, \alpha_2)$$

as the "commitment action" and

$$(4) \qquad g_1^* = \min_{\alpha_2 \in B(a_1)} g_1(a_1^*, \alpha_2)$$

as the "commitment payoff" of player one. That is g_1^* is the most player one could guarantee for herself in the stage game if she could commit to any pure strategy $a_1 \in A_1$. Note that the minimum over all $\alpha_2 \in B(a_1)$ has to be taken since player two may be indifferent between several best responses to a_1 in which case he may take the response player one prefers least.[4]

Furthermore, let $\alpha_2^* \in B(a_1^*)$ denote any strategy of player two which is a best response to a_1^* and define

$$(5) \qquad g_2^* = g_2(a_1^*, \alpha_2^*).$$

So g_2^* is the most player two would get in the stage game if player one were committed to a_1^*. Suppose $B(a_1^*) \neq \mathscr{A}_2$ (otherwise the game is "trivial" because player one's commitment payoff is her maxmin payoff). Then there is an $\tilde{a}_2 \notin B(a_1^*)$ such that

$$(6) \qquad \tilde{g}_2 = g_2(a_1^*, \tilde{a}_2) = \max_{a_2 \notin B(a_1^*)} g_2(a_1^*, a_2) < g_2^*.$$

Note that the maximum exists because it is taken over the finite set of all (pure) actions $a_2 \notin B(a_1^*)$. So $\tilde{g}_2$ is the maximum player two can get if he does not take an action which is a best response against a_1^*, given that player one takes her commitment action. Finally, define the maximal payoff player two can get at all as

$$(7) \qquad \bar{g}_2 = \max_{a_2 \in A_2} \max_{a_1 \in A_1} g_2(a_1, a_2).$$

Clearly, in the repeated game it must be true that

$$(8) \qquad V_2^t \leqslant \sum_{\tau = t}^{\infty} \delta_2^{\tau - t} \cdot \bar{g}_2 = \frac{\bar{g}_2}{1 - \delta_2} = \bar{V}_2^t$$

for all t and all $h^{t-1} \in H^{t-1}$.

[3] Note that a_1^* is defined in terms of the stage game. In the repeated game player one may want to commit herself to a more complex strategy which may be nonstationary and dependent on history, e.g. the "tit-for-tat" strategy in the repeated prisoner's dilemma. All our results hold for history dependent commitment strategies, but nothing is gained by this generalization. Games in which it is strictly desirable to commit to a history dependent strategy do not have conflicting interests as will become clear in Section 5.3. Thus, for notational convenience we restrict attention to stationary commitment strategies. The analysis can also be extended to the more general case where player one would like to commit himself to a mixed strategy. See Fudenberg and Levine (1992) and the remarks in Section 6.

[4] Fudenberg and Levine (1989) refer to g_1^* as the "Stackelberg payoff." However, it is now customary to use this expression only for $\max_{a_1} \max_{\alpha_2 \in B(a_1)} g_1(a_1, \alpha_2)$, that is for the maximum payoff player one could get if he could publicly commit himself to any action a_1 and player two chooses the best response player one prefers *most*. However, for generic games (in the space of payoff functions) the best reply of player two against a_1^* is unique. See Fudenberg (1992).

Consider now a perturbation of this complete information game such that in period 0 (before the first stage game is played) the "type" of player one is drawn by nature out of a countable set $\Omega = (\omega_0, \omega_1, \cdots)$ according to the probability measure μ. Player one's payoff function now additionally depends on her type, so g_1: $A_1 \times A_2 \times \Omega \to \mathbb{R}$. The perturbed game $G^T(\mu)$ is a game with incomplete information in the sense of Harsanyi (1967–68). In the perturbed game a strategy of player one may not only depend on history but also on her type, so σ_1^t: $H^{t-1} \times \Omega \to \mathscr{A}_1$. Two types out of the set Ω are of particular importance:

• The "normal" type of player one is denoted by ω_0. Her payoff function is the same as in the unperturbed game:

$$g_1(a_1, a_2, \omega_0) = g_1(a_1, a_2). \tag{9}$$

In many applications $\mu(\omega_0)$ will be close to 1. However, we have to require only that $\mu(\omega_0) = \mu^0 > 0$.

• The "commitment" type is denoted by ω^*. For her it is a dominant strategy in the repeated game always to play a_1^*. This is for example the case if her payoff function satisfies

$$g_1(a_1^*, a_2, \omega^*) = g_1(a_1^*, a_2', \omega^*) > g_1(a_1, a_2', \omega^*) \tag{10}$$

for all $a_1 \neq a_1^*$, $a_1 \in A_1$, and all $a_2, a_2' \in A_2$. The dominant strategy property in the repeated game implies that in any Nash equilibrium player one with type ω^* has to play a_1^* in every period along the equilibrium path. This in turn implies that if $\mu(\omega^*) = \mu^* > 0$, then with positive probability there exists a history in any Nash equilibrium with $s_1^t = a_1^*$ for all t. The set of all such histories is denoted by H^*.

We will now restate an important lemma of Fudenberg and Levine (1989) about statistical inference which is basic to the following analysis. The lemma says that if ω^* has positive probability and if player two observes a_1^* being played in every period, then there is a fixed finite upper bound on the number of periods in which player two will believe a_1^* is "unlikely" to be played. The intuition for this result is the following. Consider any history $h^{t-1} \in H^*$ in which player one has always played a_1^* up to period $t-1$. Suppose player two believes that the probability of a_1^* being played in period t is smaller than $\bar{\pi}$, $0 \leqslant \bar{\pi} < 1$. If player two observes a_1^* being played in t he is "surprised" to some extent and will update his beliefs. Because the commitment type chooses a_1^* with probability 1 while player two expected a_1^* to be played with a probability bounded away from 1 it follows from Bayes' Law that the updated probability that he faces the commitment type has to increase by an amount bounded away from 0. However, this cannot happen arbitrarily often because the updated probability of the commitment type cannot become bigger than 1. This gives the upper bound on the number of periods in which player two may expect a_1^* to be played with a probability less than $\bar{\pi}$. Note that this argument is independent of the discount factors of the two players.

To put it more formally: Each (possibly mixed) strategy profile (σ_1, σ_2) induces a probability distribution π over $(A_1 \times A_2)^\infty \times \Omega$. Given a history h^{t-1}

let $\pi^t(a_1^*)$ be the probability attached by player two to the event that the commitment strategy is being played in period t, i.e. $\pi^t(a_1^*) = \text{Prob}(s_1^t = a_1^* | h^{t-1})$. Note that since h^{t-1} is a random variable $\pi^t(a_1^*)$ is a random variable as well. Fix any $\bar{\pi}$, $0 \leqslant \bar{\pi} \leqslant 1$, and consider any history h induced by (σ_1, σ_2). Along this history let $n(\pi^t(a_1^*) \leqslant \bar{\pi})$ be the number (possibly infinite) of the random variables $\pi^t(a_1^*)$ for which $\pi^t(a_1^*) \leqslant \bar{\pi}$. Again, since h is a random variable, so is n.

LEMMA 1: *Let* $0 \leqslant \bar{\pi} < 1$. *Suppose* $\mu(\omega^*) = \mu^* > 0$, *and that* (σ_1, σ_2) *are such that* $\text{Prob}(h \in H^* | \omega^*) = 1$. *Then*

$$\text{(11)} \qquad \text{Prob}\left[n\left(\pi^t(a_1^*) \leqslant \bar{\pi}\right) > \frac{\log \mu^*}{\log \bar{\pi}} \middle| h \in H^* \right] = 0.$$

Furthermore, for any infinite history h such that the truncated histories h_t *all have positive probability and such that* a_1^* *is always played,* $\mu(\omega^* | h_t)$ *is nondecreasing in* t.

PROOF: See Fudenberg and Levine (1989), Lemma 1.

One feasible strategy for player one with type ω_0 is of course to mimic the commitment type and always to play a_1^*. Lemma 1 does not say that in this case $\mu(\omega^* | h_t \in h^*)$ converges to 1, i.e. that player two will gradually become convinced that he is facing ω^* if he observes a_1^* always being played. Rather it says that if he observes a_1^* being played in every period he cannot continue to believe that a_1^* is "unlikely" to be played.

Suppose that player two is completely myopic, that is he is only interested in his payoff of the current period. Fudenberg and Levine show that there is a $\bar{\pi} < 1$ such that if the probability that player one will play a_1^* is bigger than $\bar{\pi}$, then a short-run player two will choose a best response against a_1^*. Thus, if player one mimics the commitment type, then by Lemma 1 her short-run opponents will take $a_2 \notin B(a_1^*)$ in at most $k = \log \mu^* / \log \bar{\pi}$ periods. The worst that can happen to player one is that these k periods occur in the beginning of the game and that in each of these periods she gets

$$\text{(12)} \qquad \underline{g}_1 = \min_{\alpha_2 \in \mathscr{A}_2} g_1(a_1^*, \alpha_2).$$

This argument provides the intuition for the following theorem.

THEOREM 1 (Fudenberg-Levine): *Let* $\delta_2 = 0$, $\mu(\omega^0) > 0$, *and* $\mu(\omega^*) = \mu^* > 0$. *Then there is a constant* $k(\mu^*)$ *otherwise independent of* (Ω, μ), *such that*

$$\text{(13)} \qquad v_1(\delta_1, \mu^*; \omega^0) \geqslant \left(1 - \delta_1^{k(\mu^*)}\right) \cdot \underline{g}_1 + \delta_1^{k(\mu^*)} \cdot g_1^*,$$

where $v_1(\delta_1, \mu^*; \omega^0)$ *is any average equilibrium payoff to player one with type* ω_0 *in any Nash equilibrium of* $G^\infty(\mu)$.

If δ_1 goes to 1 the "normal" type of player one can guarantee herself on average at least her commitment payoff no matter what other types may be around with positive probability. The result is discussed in more detail in Fudenberg and Levine (1989). Note however that Theorem 1 is crucially based on the assumption that player two is completely myopic. If he cares about future payoffs, then he may trade off short-run losses against long-run gains. Thus, even if he believes that a_1^* will be played with a probability arbitrarily close or equal to 1, he may take an action a_2 which is not a short-run best response against a_1^*. One intuitive reason for this could be that he might invest in screening the different types of player one. Even if this yields losses in the beginning of the game the investment may well pay off in the future. This leads Fudenberg and Levine to conclude that their result does not apply to two long-run player games. The main point of our paper, however, is to show that for a more restricted class of games a similar result holds in the two long-run players case as well. Since player two's discount factor is smaller than 1, the returns from an investment may not be delayed too far to the future. He will not "test" player one's type arbitrarily often if the probability that she will play a_1^* is always arbitrarily close to 1. This idea will be used in Section 4 to prove an analog of Theorem 1 for two long-run player games.

3. A GAME NOT OF CONFLICTING INTERESTS

Before establishing our main result let us show that Theorem 1 does not carry over to *all* repeated games with two long-run players. We give a counterexample of a game in which the normal type of player one cannot guarantee herself almost her commitment payoff in all Nash equilibria. The example is instructive for two reasons. First, it shows how to construct an equilibrium in which the normal type of player one gets strictly less than her commitment payoff. This equilibrium is not only a Nash but a sequential equilibrium which survives all standard refinements. Second, the construction leads to a necessary and sufficient condition on the class of games for which Theorem 1 can be generalized to the two long-run player case.

Consider an infinite repetition of the following stage game with three types of player one (see Figure 1). Player one chooses between U and D and her payoff is given in the upper left corners of each cell. Clearly the normal type of player

	L	R
U	10, 10	0, 0
D	0, 0	1, 1

"normal" type
$\mu^0 = 0.8$

	L	R
U	10, 10	10, 0
D	0, 0	1, 1

"commitment" type
$\mu^* = 0.1$

	L	R
U	1, 10	1, 0
D	1, 0	1, 1

"indifferent" type
$\mu^i = 0.1$

FIGURE 1.—A game with common interests.

one would like to publicly commit always to play U which would give her a commitment payoff of 10 per period in every Nash equilibrium. For the commitment type it is indeed a dominant strategy in the repeated game always to play U. The indifferent type, however, is indifferent between U and D no matter what player two does.

If $0.75 \leqslant \delta_1 \leqslant 1$ and $0.95 \leqslant \delta_2 \leqslant 1$, then the following strategies and beliefs form a sequential equilibrium of G^{∞}:

- *Normal type of player one*: "Play U. If you ever played D, switch to playing D forever."
- *Commitment type of player one*: "Always play U."
- *Indifferent type of player one*: "Always play U along the equilibrium path. If there has been any deviation by any player in the past switch to playing D forever."
- *Player two*: "Alternate between 19 times L and 1 times R along the equilibrium path. If player one ever played D, switch to R forever. If player two himself deviated in the last period, play L in the following period. If player one reacted to the deviation by playing U, go on playing L forever. If she reacted with D, play R forever."
- *Beliefs*: Along the equilibrium path beliefs don't change. If player two ever observes D to be played, he puts probability 0 on the commitment type. If player one reacts to a deviation of player two by playing U, the indifferent type gets probability 0. In both cases the respective two other types may get arbitrary probabilities which add up to 1.

In the limit, as $\delta_1 \to 1$, these strategies give the normal type of player one a payoff of

$$(14) \qquad \lim_{\delta_1 \to 1} v_1(\omega^0) = 9.5 < 10 = g_1^*.$$

Why is this an equilibrium? Consider the normal type of player one. Clearly she would like to signal that she is the normal or the commitment type. Since all three types of player one always play U along the equilibrium path the only way to transmit information about her type is to play D. However, playing D "kills" the commitment type, because for her it is a dominant strategy always to play U. But without the commitment type it is impossible to get rid of the "bad" equilibrium (D, R). What about player two? He expects U always to be played along the equilibrium path. Nevertheless he plays R, which is not a short-run best response, in every twentieth period. His problem is that he faces the indifferent type with positive probability. If he chooses L when he is supposed to play R, then this might trigger a continuation equilibrium against the indifferent type which gives him far less than that which he would have obtained from playing against the normal or commitment type of player one. It is this risk which sustains the equilibrium outcome.

Note that there are very few restrictions imposed on the updating of beliefs in information sets which are not reached on the equilibrium path. The example only requires that if D is played for the first time, the commitment type gets probability 0, which is perfectly reasonable given that for her it is a dominant strategy in the repeated game always to play U.

To what extent does the example rely on the existence of the indifferent type? Without the indifferent type it is still possible to construct a Nash equilibrium which gives player one less than her commitment payoff. Actually, this is very simple: The normal and the commitment type of player one always play U along the equilibrium path. After any deviation they switch to playing D forever. Player two alternates playing one period L and one period R. If there has been any deviation, he plays R forever. If the discount factors are high enough these strategies form a Nash equilibrium for any $\mu^* > 0$. Here the average payoff of the normal type of player one is 5. Note, however, that this equilibrium is not sequential. It requires for example that the commitment type plays D off the equilibrium path.[5]

What sustains both equilibria is the possibility of a continuation equilibrium which punishes player two if he plays his short-run best response against a_1^* in periods when he is supposed not to do so. Note that this construction does not work if player two is already held down to his minimax payoff by the commitment strategy of player one, since in this case nothing worse can happen to him. In the next section we show that this is the only case in which Fudenberg and Levine's result can be generalized to the two long-run player case.

4. MAIN RESULTS

4.1. *The Theorem*

Suppose that the commitment strategy of player one holds player two down to his minimax payoff. In this case there is no "risk" in playing a best response against a_1^* because player two cannot get less than his minimax payoff in any continuation equilibrium. This motivates the following definition:

DEFINITION 1: A game g is called a *game of conflicting interests with respect to player one* if the commitment strategy of player one holds player two down to his minimax payoff, i.e. if

$$g_2^* = g_2(a_1^*, \alpha_2^*) = \min_{\alpha_1} \max_{\alpha_2} g_2(\alpha_1, \alpha_2). \tag{15}$$

"Conflicting interests" are a necessary and sufficient condition for our main result. Note that the definition puts no restriction on the possible perturbations of the payoffs of player one. It is a restriction only on the commitment strategy and on the payoff function of player two. We will discuss this class of games extensively and give several examples in Section 5. Clearly, in a game with conflicting interests player two can guarantee himself in any continuation

[5] Whether there exists a *sequential* equilibrium in which player one gets substantially less than 10 if there are only the normal and the commitment type around is an open question. Note, however, that we want to characterize equilibrium outcomes which are robust to general perturbations of the informational structure of the game. From this perspective it makes little sense to restrict attention to two possible types only.

equilibrium after any history h_t at least

$$(16)\qquad \underline{V}_2^{t+1} = \frac{1}{1-\delta_2} \cdot g_2^*.$$

This is crucial to establish the following result:

LEMMA 2: *Let g be a game of conflicting interests with respect to player one and let $\mu(\omega^*) = \mu^* > 0$. Consider any Nash equilibrium $(\hat{\sigma}_1, \hat{\sigma}_2)$ and any history h^t consistent with this equilibrium in which player one has always played a_1^*. Suppose that, given this history, the equilibrium strategy of player two prescribes to take $s_2^{t+1} \notin B(a_1^*)$ with positive probability in period $t+1$. For any δ_2, $0 < \delta_2 < 1$, there exists a finite integer M,*

$$(17)\qquad M \geqslant N = \frac{\ln(1-\delta_2) + \ln(g_2^* - \tilde{g}_2) - \ln(\bar{g}_2 - \tilde{g}_2)}{\ln \delta_2} > 0,$$

and a positive number ε,

$$(18)\qquad \varepsilon = \frac{(1-\delta_2)^2 \cdot (g_2^* - \tilde{g}_2)}{\bar{g}_2 - \tilde{g}_2} - \delta_2^M \cdot (1-\delta_2) > 0,$$

such that in at least one of the periods $t+1, t+2, \cdots, t+M$ the probability that player one does not take a_1^*, given that he always played a_1^* before, must be at least ε.

PROOF: See Appendix.

Let us briefly outline the intuition behind this result. Because g is of conflicting interests player two can guarantee himself at least $\underline{V}_2^{t+1} = g_2^*/(1-\delta_2)$ in any continuation equilibrium after any history h_t. Therefore, if he tries to test player one's type and takes an action $s_2^{t+1} \notin B(a_1^*)$ in period $t+1$ this must give him an expected payoff of at least $\underline{V}_2^{t+1}$ for the rest of the game. If player one chooses a_1^* with a probability arbitrarily close or equal to 1, then choosing an action $a_2 \notin B(a_1^*)$ yields a "loss" of at least $g_2^* - \tilde{g}_2 > 0$ in this period. Recall that $\tilde{g}_2$ is defined as the maximal payoff player two gets if he does not take a best response against a_1^*. On the other hand, $\bar{g}_2$ is an upper bound on what player two may get in any period in which player one does not take her commitment action, and—of course—he cannot get more than g_2^* if she plays a_1^*. But if future payoffs are bounded and $\delta_2 < 1$, then the compensation for an expected loss today must not be delayed too far to the future. The numbers M and ε are constructed such that if player two takes a strategy $s_2^{t+1} \notin B(a_1^*)$ in period $t+1$, then it cannot be true that in each of the next M periods the probability that player one takes her commitment action is bigger than $(1-\varepsilon)$. Otherwise player two would get less than his minimax payoff in equilibrium, a contradiction. Note that this argument also holds for finitely repeated games if T is large enough.

Lemma 2 holds in any proper subform of G as long as player one always played a_1^* in the history up to that subform. Thus if player two chooses actions $a_2 \notin B(a_1^*)$ along h^* in $n \cdot M$ periods, then in at least n of these periods the probability that player one does not play a_1^* must be at least ε. Together with Lemma 1 this implies our main theorem:

THEOREM 2: *Let g be of conflicting interests with respect to player one and let $\mu(\omega^0) > 0$, and $\mu(\omega^*) = \mu^* > 0$. Then there is a constant $k(\mu^*, \delta_2)$ otherwise independent of (Ω, μ), such that*

$$(19) \qquad v_1(\delta_1, \delta_2, \mu^*; \omega^0) \geqslant \left(1 - \delta_1^{k(\mu^*, \delta_2)}\right) \cdot \underline{g}_1 + \delta_1^{k(\mu^*, \delta_2)} \cdot g_1^*,$$

where $v_1(\delta_1, \delta_2, \mu^*; \omega^0)$ is any average equilibrium payoff of player one with type ω_0 in any Nash equilibrium of $G^\infty(\mu)$.

PROOF: Consider the strategy for the normal type of player one of always playing a_1^*. Take the integer $M = [N] + 1$, where $[N]$ is the integer part of N, and a real number $\varepsilon > 0$, where N and ε are defined in Lemma 2. By Lemma 2 we know that if player two takes an action $a_2 \notin B(a_1^*)$, then there is at least one period (call it τ_1) among the next M periods in which the probability that player one will play a_1^* (denoted by $\pi_{\tau_1}^*$) is smaller than $(1 - \varepsilon)$. So

$$(20) \qquad \pi_{\tau_1}^* < 1 - \varepsilon \equiv \bar{\pi}.$$

However, by Lemma 1 we know that

$$(21) \qquad \pi\left[n(\pi_t^* \leqslant \bar{\pi}) > \frac{\ln \mu^*}{\ln \bar{\pi}} \middle| h^*\right] = 0.$$

That is, the probability that player one takes her commitment action cannot be smaller than $\bar{\pi}$ in more than $\ln \mu^* / \ln \bar{\pi}$ periods. Therefore, player two cannot choose actions $a_2 \notin B(a_1^*)$ more often than

$$(22) \qquad k = M \cdot \frac{\ln \mu^*}{\ln(1 - \varepsilon)}$$

times. Substituting $M = [N] + 1$ and ε from Lemma 2, we get

$$(23) \qquad k(\mu^*, \delta_2) = ([N] + 1) \cdot \frac{\ln \mu^*}{\ln\left(1 - \dfrac{(1 - \delta_2) \cdot (g_2^* - \tilde{g}_2)}{\bar{g}_2 - \tilde{g}_2} + \delta_2^{[N]+1}\right)}.$$

In the worst case player two chooses these actions in the first $k(\mu^*, \delta_2)$ periods. This gives the lower bound of the theorem. *Q.E.D.*

If $\delta_1 \to 1$ (keeping δ_2 fixed), then the equilibrium payoff of the normal type of player one is bounded below by her commitment payoff. Thus, in the limit our theorem gives the same lower bound as Fudenberg and Levine's theorem does for the case of a long-run player facing a sequence of short-run opponents.

Their result can be obtained as a special case of Theorem 2 for the class of games with conflicting interests. Note that if δ_2 goes to 0, then N goes to 0. So

$$(24)\qquad \lim_{\delta_2 \to 0} k(\mu^*, \delta_2) = \frac{\ln \mu^*}{\ln\left(1 - \dfrac{g_2^* - \tilde{g}_2}{\bar{g}_2 - \tilde{g}_2}\right)} = \frac{\ln \mu^*}{\ln\left(\dfrac{\bar{g}_2 - g_2^*}{\bar{g}_2 - \tilde{g}_2}\right)}.$$

In a game with conflicting interests a short-run player two will play a best response against a_1^* if

$$(25)\qquad g_2^* > \pi \cdot \tilde{g}_2 + (1 - \pi) \cdot \bar{g}_2$$

or, equivalently, if

$$(26)\qquad \pi > \frac{\bar{g}_2 - g_2^*}{\bar{g}_2 - \tilde{g}_2} \equiv \bar{\pi}.$$

Using (26) in Lemma 1 immediately implies Theorem 1.

It is important to note that the lower bound given in Theorem 2 depends on the discount factor of player 2. If δ_2 increases, so does $k(\mu^*, \delta_2)$, and the lower bound is reduced. Hence, to obtain his commitment payoff in equilibrium, player one has to be sufficiently patient as compared to player two. The following corollaries elaborate on the importance of the relative patience of the players.

Corollary 1: *For any $\delta_2 < 1$, $\mu^* > 0$ and $\varepsilon > 0$, there exists a $\underline{\delta}_1(\delta_2, \mu^*, \varepsilon) < 1$, such that for any $\delta_1 \geqslant \underline{\delta}_1(\delta_2, \mu^*, \varepsilon)$ the average payoff of the normal type of player one is at least $g_1^* - \varepsilon$.*

Proof: Choose $\underline{\delta}_1$ such that

$$(27)\qquad g_1^* - \varepsilon = \left(1 - \underline{\delta}_1^{k(\mu^*, \delta_2)}\right) \cdot \underline{g}_1 + \underline{\delta}_1^{k(\mu^*, \delta_2)} \cdot g_1^*.$$

Solving for $\underline{\delta}_1$ yields

$$(28)\qquad \underline{\delta}_1 = \underline{\delta}_1(\mu^*, \delta_2, \varepsilon) = \sqrt[k(\mu^*, \delta_2)]{\frac{g_1^* - \underline{g}_1 - \varepsilon}{g_1^* - \underline{g}_1}} < 1.$$

Clearly, if $\delta_1 \geqslant \underline{\delta}_1(\mu^*, \delta_2, \varepsilon)$, then

$$(29)\qquad v_1(\delta_1, \delta_2, \mu^*; \omega^0) \geqslant \left(1 - \delta_1^{k(\mu^*, \delta_2)}\right) \cdot \underline{g}_1 + \delta_1^{k(\mu^*, \delta_2)} \cdot g_1^*$$
$$\geqslant \left(1 - \underline{\delta}_1^{k(\mu^*, \delta_2)}\right) \cdot \underline{g}_1 + \underline{\delta}_1^{k(\mu^*, \delta_2)} \cdot g_1^* = g_1^* - \varepsilon.$$

Q.E.D.

Corollary 2: *Consider any sequence $\{\delta_2^n\}$, $\delta_2^n < 1$, $\lim_{n \to \infty} \delta_2^n = 1$ and fix $\varepsilon > 0$. Then there exists a sequence $\{\delta_1^n\}$, $\delta_1^n < 1$, $\lim_{n \to \infty} \delta_1^n = 1$, such that for any $\{\delta_1^n, \delta_2^n\}$ the average payoff of the normal type of player one is bounded below by $g_1^* - \varepsilon$.*

PROOF: Take any $\{\delta_2^n\}$ and fix $\varepsilon > 0$. Choose $\{\delta_1^n\} \to 1$ such that $\delta_1^n > \underline{\delta}_1(\delta_2^n, \mu^*, \varepsilon)$ for all n, where $\underline{\delta}_1(\delta_2^n, \mu^*, \varepsilon)$ is given by (28). Then the result follows immediately from the previous corollary. *Q.E.D.*

Corollary 2 shows that there is an area in the (δ_1, δ_2)-space such that for any sequence $\{\delta_1^n, \delta_2^n\} \to (1,1)$ in this area player one gets at least her commitment payoff (up to an arbitrarily small ε) for any pair of discount factors along this sequence. Note, however, that $\lim_{n\to\infty}(1-\delta_1)/(1-\delta_2) = 0$, i.e. in the limit player one is infinitely more patient than player two. This observation helps to understand a related result of Cripps and Thomas (1991) who consider repeated games without discounting, in which players maximize the limit of the mean of their payoffs. Under slightly stronger conditions on the possible perturbations they show that if the game has conflicting interests and if there is a positive prior probability of a commitment type, then player one gets at least her commitment payoff as the Banach limit of the mean of her stage game payoffs. However, the case of no discounting obscures the role of the relative patience of the players. We can give examples of equilibria in games with conflicting interests where $\delta_1 \to 1$, $\delta_2 \to 1$, $\lim_{n\to\infty}(1-\delta_1)/(1-\delta_2) > 0$, and player one's equilibrium payoff is bounded away from her commitment payoff for any $\{\delta_1^n, \delta_2^n\}$ along this sequence. Thus, if player one is not patient enough as compared to player two, our lower bound does not apply.

If player one has to be much more patient than player two, the reader might be left with the impression that we are essentially back to Fudenberg and Levine (1989) where a long-run player faces a sequence of short-run players. However, this is not the case. First, Fudenberg and Levine's result requires $\delta_2 = 0$ while here δ_2 may be arbitrarily close to 1. Second, we are going to show in the next subsection that, whenever the game is not of conflicting interests, it is possible to find an equilibrium which violates Fudenberg and Levine's lower bound no matter how much more patient player one is as compared to player two. Thus, there is a fundamental difference between repeated games in which one player does not care at all about her future payoffs and games in which she does care but is less patient than her opponent. Finally, the importance of the relative patience of the two players is very intuitive as will be shown after we have introduced the case of two-sided uncertainty in subsection 4.3.

4.2. *Necessity of the "Conflicting Interests" Condition*

The question arises whether Theorem 2 also holds for games which are not of conflicting interests. If the game is not "trivial" in the sense that player one's commitment payoff is equal to her minimax payoff,[6] the answer is no.

PROPOSITION 1: *Let g be a nontrivial game which is not of conflicting interests. Then for any $\varepsilon > 0$ there is an $\eta > 0$ and a $\underline{\delta}_2 < 1$ such that the following holds:*

[6] It is well known that a player can always guarantee herself at least her minimax payoff in any Nash equilibrium.

There is a perturbation of g, *in which the commitment type of player* 1 *has positive probability and the normal type has probability* $(1-\varepsilon)$, *and there is a sequential equilibrium of this perturbed game, such that the limit of the average payoff of the normal type of player one for* $\delta_1 \to 1$ *is bounded away from her commitment payoff by at least* η *for any* $\delta_2 > \underline{\delta}_2$.

PROOF: See Appendix.

Proposition 1 shows that the condition of conflicting interests is not only sufficient but also necessary for Theorem 2 to hold; in fact, it is a little bit stronger than that in two respects. First, it says that if the game is not of conflicting interests, then it is not only possible to find a Nash equilibrium which violates Fudenberg and Levine's lower bound, but also to find a sequential equilibrium. As has been indicated in Section 3, the construction of a Nash equilibrium using threats which are not credible is much simpler. Secondly, Theorem 2 only requires that $\mu(\omega^0) > 0$ in the perturbed game. So we could have established necessity by constructing a perturbation which gives a high prior probability to an "indifferent" type who credibly threatens to punish any deviation of player two from the equilibrium path we want to sustain. However, in many economic applications it is natural to assume that $\mu(\omega^0)$ is close to 1. This is why we provide a stronger proposition which says that even if $\mu(\omega^0)$ is arbitrarily close to 1 it is possible to construct a sequential equilibrium in which the payoff of the normal type of player one is bounded away from g_1^*.

Note that in Proposition 1 $\delta_1 \to 1$, while δ_2 is fixed, so player one may be arbitrarily more patient than player two. Thus, Proposition 1 shows that there is an important difference between games with two long run players, one of whom is more patient than the other, and games in which a long-run player faces a sequence of short-run players. In the latter, Fudenberg and Levine's bound holds for all stage games; in the former, it holds only for games with conflicting interests.

4.3. *Two-sided Incomplete Information and Two-sided Conflicting Interests*

If there are two long-run players it is most natural to ask what happens if there is two-sided uncertainty. Our result can be extended to this case in the following way. Suppose the game is perturbed such that there is incomplete information about both the payoff functions of player one and player two. Let ω_i denote player i's type which is drawn by nature in the beginning of the game out of the countable set Ω_i according to the probability measure μ_i, $i \in \{1,2\}$. Let ω_i^0 and ω_i^* represent the normal and the commitment types, respectively. Finally, suppose that the game is of conflicting interests with respect to player i, i.e. player i's commitment strategy holds player j down to his minimax payoff. Without loss of generality let $i = 1$. Now consider the normal type of player two. In the proof of Lemma 2 we did not say why player two might choose an action which is not a best response against player one's commitment strategy. He might do so because he wants to test player one's type or because he wants to build up a reputation himself. No matter what the reason is, Lemma 2 states that if he takes $a_2 \notin B(a_1^*)$, then he must expect that player one chooses $s_1^t \neq a_1^*$ in one of the following periods with strictly positive probability. This argument holds for the normal type of player two no matter what other possible types of player two exist with positive probability.

A possible strategy of player one still is to play a_1^* in every period. If she faces the normal type of player two, then by Theorem 2 there are at most $k(\mu_i^*, \delta_2)$ periods in which player two will not play a best response against a_1^*. In the worst case for player one this happens in the first k periods of the game. On the other hand, if she does not face the normal type of player two her expected payoff is at least $\underline{g}_1$ in every period. This argument establishes a lower bound for the expected payoff of the normal type of player i which is given in the following theorem.

THEOREM 3: *Let g be of conflicting interests with respect to player i and let $\mu_i(\omega_i^0) = \mu_i^0 > 0$ and $\mu_i(\omega_i^*) = \mu_i^* > 0$, $i \in \{1,2\}$. Then there are constants $k_i(\mu_i^*, \delta_j)$, otherwise independent of $(\Omega_i, \Omega_j, \mu_i)$, such that*

$$(30) \qquad v_i\left(\delta_i, \delta_j, \mu_i^*, \mu_j^0; \omega_i^0\right) \geq \left(1 - \mu_j^0 \delta_i^{k_i(\mu_i^*, \delta_j)}\right) \underline{g}_i + \mu_j^0 \delta_i^{k_i(\mu_i^*, \delta_j)} g_i^*$$

where $v_i(\delta_1, \delta_2, \mu_i^*, \mu_j^0; \omega_i^0)$ is any average equilibrium payoff of player i with type ω_i^0 in any Nash equilibrium of $G^\infty(\mu)$.

Thus, if the probability of the normal type of player two is close to 1 and if player one is very patient, then the lower bound for her average payoff is again close to her commitment payoff.

What can be said if g has two-sided conflicting interests, i.e. if each player would like to commit to a strategy which holds his opponent down to his minimax payoff? Of course, if there are two-sided conflicting interests and if both players are equally patient, it is impossible that each of them gets his most preferred payoff. But suppose that δ_i and δ_j differ. The bigger player j's discount factor, the bigger is $k_i(\mu_i^*, \delta_j)$, i.e. the number of periods in which player i must expect that a strategy other than the best response against her commitment strategy is played, and the lower is her lower bound. On the other hand, if δ_j is kept fixed and δ_i goes to 1, then this k periods become less and less important, and in the limit player i will get his commitment payoff. This is very intuitive. In a symmetric game with conflicting interests reputation building has an effect only if one of the parties is sufficiently more patient than the other.

Theorems 2 and 3 are in striking contrast to the message of the Folk Theorem for games with incomplete information by Fudenberg and Maskin (1986). The Folk Theorem says that for any finitely or infinitely repeated game there exists an ε perturbation of this game (in which each of the players has a different payoff function with a small prior probability ε) such that any individually rational, feasible payoff vector can be sustained as the outcome of a sequential equilibrium of the perturbed game, if the players are sufficiently patient.[7] To sustain any particular payoff vector as an equilibrium outcome the "right" perturbation has to be chosen, that is there must be one particular "crazy" type with probability ε who sustains this equilibrium by following a particular strategy. Theorems 2 and 3 show that this result is not robust against further perturbations of the informational structure. If one of the players is patient enough and if her commitment type has positive probability, then—no matter what other types are around with positive probability—Theorems 2 and 3 impose a tight restriction on the set of equilibrium outcomes in any Nash equilibrium.

We have to be very precise here in what is meant by "robustness." Fudenberg (1992) argues that strict equilibria can be constructed to prove the Folk Theorem. Thus, if the discount factor is kept fixed, the equilibrium is not upset by introducing arbitrary additional types with a very small probability. In this sense the Folk Theorem is robust. However, if we introduce different types (including the commitment type) with a very small probability, keep the perturbation fixed, and then let the discount factor of player one go to 1, then all equilibria which give player one less than his commitment payoff will eventually break down. Thus, if we are interested in the set of equilibria for $\delta_1 \to 1$, the Folk Theorem is not robust against small perturbations of the informational structure.

5. EXAMPLES

5.1. *The Chain Store Game*

Consider the classical chain store game, introduced by Selten (1978), with two long-run players. In every period the entrant may choose to enter a market (I) or to stay out (O), while the monopolist has to decide whether to acquiesce (A) or to fight (F). Assume that the payoffs of the unperturbed stage game are given in Figure 2.

The monopolist would like to commit to fight in every period which would give her a commitment payoff of 3 and which would hold the entrant down to 0. Since 0 is also player two's minimax payoff, the game is—according to our definition—of conflicting interests with respect to the monopolist. Kreps and Wilson (1982) have analyzed finite repetitions of this game with some incomplete information about the monopolist's type. For a particular perturbation of player one's payoff function they have shown that there are sequential equilibria in which the monopolist gets on average almost her commitment payoff if her discount factor is close enough to 1 and if there are enough repetitions. However, Fudenberg and Maskin (1986) demonstrated that any feasible payoff

[7] Fudenberg and Maskin's Folk Theorem for games with incomplete information considers only finitely repeated games without discounting. However, the extension to discounting and an infinite horizon is straightforward.

	I	O
A	1, 2	3, 0
F	0, -1	3, 0

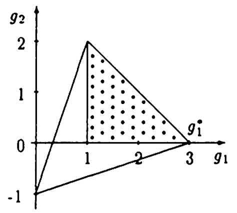

FIGURE 2.—The chain store game.

vector which gives each player more than his minimax payoff, i.e. any point in the shaded area of Figure 2, can be sustained as an equilibrium outcome if the "right" perturbation is chosen. Thus, our Theorem 2 considerably strengthens the result of Kreps and Wilson (1982). It says that the only Nash equilibrium outcome of this game which is robust against any perturbation gives the monopolist at least her commitment payoff of 3 (note that she cannot get more), if she is sufficiently patient as compared to the entrant.[8] Furthermore it shows that this result carries over to the infinitely repeated game.

Now suppose that there is also incomplete information about the payoff function of the entrant. He would like to commit to enter in every period which would give him a commitment payoff of 2 while it would hold the monopolist down to 1, her minimax payoff. So the game is also of conflicting interests with respect to the entrant and our theorem applies. If there is two-sided uncertainty, Proposition 2 says that it all depends on the relative patience of the two players and the prior probability distribution. If player one is sufficiently *more* patient than player two and if the probability of the normal type of player two is close to 1, then player one will get her commitment payoff in any Nash equilibrium, and vice versa.[9]

5.2. *A Repeated Bargaining Game*

Consider a buyer (b) and a seller (s) who bargain repeatedly in every period on the sale of a perishable good. The valuation of the buyer is 1 and the production costs of the seller are 0. Suppose there is a sealed bid double auction in every period: Both players simultaneously submit bids p_b and p_s, $p_i \in \{1/n, 2/n, \cdots, n/n\}$, and there is trade at price $p = (p_b + p_s)/2$ if and only if $p_b \geqslant p_s$. Consider the commitment strategy of the buyer. She would like to commit herself to offer $p_b^* = 1/n$ in every period. The unique best reply of the

[8] I am grateful to Eric van Damme for the following observation: Theorem 2 does not imply that the average payoff of player two is 0. Recall that player one is more patient than player two. So it may be that in the beginning of the game, say until period L, she gets less than 3 and player two gets more than 0, but after period L payoffs are always (3, 0). For player one the first L periods do not count very much because she is very patient, so her average payoff is 3. However, player two puts more weight on the first L periods and less on everything thereafter, so her average discounted payoff may be considerably bigger than 0.

[9] Another famous example of a game with conflicting interests is the "Game of Chicken." See Russell (1959, p. 30) for a description.

seller is $p_s = 1/n$, which gives him $g_s^* = 1/n$, his minimax payoff. Suppose the payoff function of the buyer is perturbed such that with some positive probability she will always offer p_b^*. Then Theorem 2 applies and the buyer will get almost her commitment payoff of $(n-1)/n$ on average in any Nash equilibrium if her discount factor is close to 1.

Note, however, that this example is not as clear-cut as the chain store game. We have to assume that there is a minimal bid $1/n > 0$. If the buyer could offer $p_b = 0$, she could hold the seller down to a minimax payoff of 0. But if he gets 0, the seller is indifferent between all possible prices, so he might choose $p_s > 0$ and we end up with no trade. The point is that bargaining over a pie of fixed size is not quite a game of conflicting interests. Some cooperation is needed to ensure that trade takes place at all.

In Schmidt (1992) we consider a more complex extensive form game of repeated bargaining with one-sided asymmetric information, which confirms the above result that the informed player can use the incomplete information about his type to credibly threaten to accept only offers which are very favorable to him. There, however, we take a different approach and it is interesting to compare the two models. In Schmidt (1992) we do not allow for "all possible" but only for "natural" perturbations of player one's payoff function, i.e. we assume that there may be incomplete information about the seller's costs, $c \in [0, 1]$. We show that, in any sequential equilibrium satisfying a weak Markov property, the buyer will try to test the seller's type at most a fixed finite number of times, and this will happen only in the end of the game. Surprisingly (from the point of view of Theorem 2) we can show that the seller will get his commitment payoff even if he is much *less patient* than the buyer, so the relative discount factors are not crucial. Furthermore, the bargaining game we consider there is not of conflicting interests.[10] There are common interests as well, because players have to cooperate to some extent in order to ensure that trade takes place.

5.3. *Games with Common and Conflicting Interests*

"Pure" conflicting interests are a polar case and in most economic applications there are both—common and conflicting—interests present. Consider for example the repeated prisoner's dilemma depicted in Figure 3. In a formal sense this game is of conflicting interests, but our theorem has no bite. Given that player two takes a best response against her commitment action, player one would like most to commit herself to play D(efect) in every period. This holds player two down to his minimax payoff, but it only gives player one her minimax payoff as well. So, trivially she will get at least her commitment payoff in every Nash equilibrium. In this game the problem is not to commit to hold player two down to his minimax payoff, but to commit to cooperation.

[10] Note that not all possible perturbations are permitted. This is why conflicting interests are not a necessary condition for the result in Schmidt (1992).

	C	D
C	2, 2	0, 3
D	3, 0	1, 1

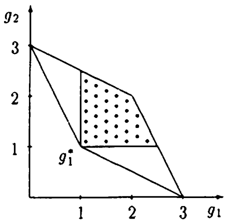

FIGURE 3.—The prisoner's dilemma.

	L	M	R
U	3, 2	0, 1	0, 1
D	0, −1	0, −1	2, 0

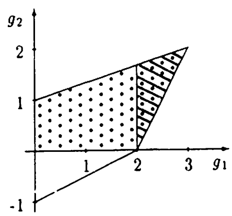

FIGURE 4

In the prisoner's dilemma game player one might do better if she could commit herself to a history dependent strategy such as "tit-for-tat". However, if we allow for the possibility of a "tit-for-tat" commitment type, the game is no longer of conflicting interests: the commitment strategy has to hold player two down to her minimax payoff in every period. For generic games this is only satisfied by stationary commitment strategies.

If the game is not of conflicting interests, Proposition 1 shows that the lower bound of Fudenberg and Levine does not hold. In this case we cannot give a *tight* prediction of player one's equilibrium payoff, but our results may still be useful to restrict the set of equilibrium outcomes as compared to the prediction of the Folk Theorem.[11] To see this, note that our reasoning in Lemma 2 does not rely on the assumption that player one's *most preferred* commitment strategy is to hold player two down to his minimax payoff. If there is positive probability of a type who minimaxes player two, and if the normal type of player one chooses to mimic this type, then there can be only a finite number of periods in which player two does not choose a best response against the minimax strategy. Otherwise he would get less than his minimax payoff. Thus, if player one is patient enough she must get at least as much as she would get if she could publicly commit to the strategy that minimaxes player two.

This is illustrated by the game depicted in Figure 4. Note that the game is not of conflicting interests because the strategy to which player one would most like to commit herself (U) does not hold player two down to his minimax payoff. However, player one has the option to mimic a type who always plays D. This minimaxes player two, so ultimately he has to take a best response against it. Thus, if player one is patient enough she can guarantee herself at least an

[11] I am grateful to Drew Fudenberg for the following observation.

average payoff of 2. In contrast, the Folk Theorem would predict any payoff bigger than 0 for player one.

6. EXTENSIONS AND CONCLUSIONS

To keep the argument as clear as possible we considered a very simple class of possible stage games with only two players, finite strategy sets, a countable set of possible types, and commitment types who always take the same pure action in every period. All of these assumptions can be relaxed without changing the qualitative results. Fudenberg and Levine (1989) provide a generalization to n-player games in which the strategy sets are compact metric spaces and in which there is a continuum of possible types of player one.[12] In Fudenberg and Levine (1992) they show that the argument can be extended to the case where the commitment types play mixed strategies and to games with moral hazard, in which not the action of player one itself but only a noisy signal can be observed by player two. Since the technical problems involved in these generalizations are the same as in our model, we refer to their work for any formal statements and proofs.

Fudenberg and Levine (1989) also demonstrated that the assumption that the stage game is simultaneous-move cannot be relaxed without an important qualification of their Theorem 1. The problem is that in an extensive form game player two may take an action after which player one has no opportunity to show that her strategy is the commitment strategy. Consider for example a repeated bargaining game in which in every period the buyer has to decide first whether to buy or not and then the seller has to choose whether to deliver high or low quality. If the buyer decides not to buy, then he will not observe whether the seller would have produced high quality. This is why the seller might fail to get her commitment payoff in equilibrium. Note however that this problem does not arise in our context. The definition of a game with conflicting interests assumes that the commitment strategy of player one holds player two down to his minimax payoff. Therefore, if player two takes an action a_2 in equilibrium after which player one's commitment strategy a_1^* is observationally equivalent to some other strategy $a_1 \neq a_1^*$, then player two cannot get more than his minimax payoff. So a_2 must have been an element of $B(a_1^*)$. However, player one's commitment payoff is defined as $g_1^* = \max_{a_1 \in A_1} \min_{\alpha_2 \in B(a_1^*)} g_1(a_1, \alpha_2)$. So if player two chooses $a_2 \in B(a_1^*)$ player one cannot get less than g_1^*. Therefore, following Theorem 2 of Fudenberg and Levine (1989), it is straightforward that our result holds without qualification if g is any finite extensive form game.

To conclude, this paper has shown that "reputation effects" give rise to a tight prediction of the equilibrium outcome in repeated games with conflicting interests. If one of the players is very patient as compared to the other player, then any Nash equilibrium outcome which is robust against perturbations of the

[12] If $n \geq 3$, the definition of a game of conflicting interests requires that a_1^* hold all other players $i = 2, \ldots, n$ down to their minimax payoffs simultaneously.

informational structure gives her on average almost her commitment payoff. This indicates that the message of the Folk Theorem may be misleading. However, we still know very little about the evolution of commitment and cooperation in games in which both—common and conflicting—interests are present, which clearly is one of the most important issues of future research.

Wirtschaftspolitische Abteilung, University of Bonn, Adenauerallee 24, D-5300 Bonn 1, Germany

Manuscript received April, 1991; final revision received August, 1992.

APPENDIX

PROOF OF LEMMA 2: Consider any equilibrium (σ_1, σ_2) and fix a history h^t up to any period t along which player one has always played a_1^*, such that h^t has positive probability given (σ_1, σ_2). Such a history exists because $\mu^* > 0$. Suppose that according to the (possibly mixed) equilibrium strategy σ_2^{t+1} player two chooses $s_2^{t+1} \notin B(a_1^*)$ in period $t+1$ with positive probability. Suppose further that the probability of player one not playing a_1^* (given that he always played a_1^* before) in each of the periods $t+1, t+2, \cdots, t+M$ is smaller than ε. It will be shown that this can't be true in equilibrium because then player two would get less than his minimax payoff.

Note that ε is independent of t and that M has been chosen in a way to guarantee that $\varepsilon > 0$. Define $\pi^\tau(a_1) = \text{Prob}(s_1^\tau = a_1 | h^{\tau-1})$ and let $V_2^\tau(s_1^\tau, \sigma_2^\tau)$ be the continuation payoff of player two from period τ onwards (and including period τ) given the strategy profile $(s_1^\tau, \sigma_2^\tau)$ in period τ. The expected payoff of player two from period $t+1$ onwards is given by

$$
\begin{aligned}
(31)\qquad & V_2^{t+1}(\sigma_1, \sigma_2) \\
&= \sum_{a_1 \neq a_1^*} \pi^{t+1}(a_1) \cdot V_2^{t+1}\left(a_1, s_2^{t+1}\right) + \pi^{t+1}(a_1^*) \\
&\quad \cdot \Bigg\{ g_2\left(a_1^*, s_2^{t+1}\right) \\
&\quad + \delta_2 \cdot \sum_{a_1 \neq a_1^*} \pi^{t+2}(a_1) \cdot V_2^{t+2}\left(a_1, \sigma_2^{t+2}\right) + \delta_2 \cdot \pi^{t+2}(a_1^*) \\
&\quad \cdot \Bigg\{ g_2\left(a_1^*, \sigma_2^{t+2}\right) \\
&\quad + \cdots + \\
&\quad + \delta_2 \cdot \sum_{a_1 \neq a_1^*} \pi^{t+M}(a_1) \cdot V_2^{t+M}\left(a_1, \sigma_2^{t+M}\right) \\
&\quad + \delta_2 \cdot \pi^{t+M}(a_1^*) \cdot \left\{ g_2\left(a_1^*, \sigma_2^{t+M}\right) + \delta_2 \cdot V_2^{t+M+1} \right\} \cdots \Bigg\} \Bigg\}.
\end{aligned}
$$

It will be convenient to substract $\bar{g}_2$ from both sides of the equation in every period. (Recall that $\bar{g}_2$ is the maximal payoff for player two if he takes an action which is not a best response against a_1^*.)

Then we get

$$
\begin{aligned}
(32)\qquad & V_2^{t+1}(\sigma_1, \sigma_2) - \frac{\bar{g}_2}{1-\delta_2} \\
&= \sum_{a_1 \neq a_1^*} \pi^{t+1}(a_1) \cdot \left[V_2^{t+1}\left(a_1, s_2^{t+1}\right) - \frac{\bar{g}_2}{1-\delta_2} \right] \\
&\quad + \pi^{t+1}(a_1^*) \cdot \Bigg\{ \left[g_2\left(a_1^*, s_2^{t+1}\right) - \bar{g}_2 \right] \\
&\qquad + \delta_2 \sum_{a_1 \neq a_1^*} \pi^{t+2}(a_1) \cdot \left[V_2^{t+2}\left(a_1, \sigma_2^{t+2}\right) - \frac{\bar{g}_2}{1-\delta_2} \right] \\
&\qquad + \delta_2 \cdot \pi^{t+2}(a_1^*) \cdot \Bigg\{ \left[g_2\left(a_1^*, \sigma_2^{t+2}\right) - \bar{g}_2 \right] \\
&\qquad\qquad + \cdots + \\
&\qquad\qquad + \delta_2 \cdot \sum_{a_1 \neq a_1^*} \pi^{t+M}(a_1) \\
&\qquad\qquad \cdot \left[V_2^{t+M}\left(a_1, \sigma_2^{t+M}\right) - \frac{\bar{g}_2}{1-\delta_2} \right] \\
&\qquad\qquad + \delta_2 \cdot \pi^{t+M}(a_1^*) \cdot \Bigg\{ \left[g_2\left(a_1^*, \sigma_2^{t+M}\right) - \bar{g}_2 \right] \\
&\qquad\qquad\qquad + \delta_2 \cdot \left[V_2^{t+M+1} - \frac{\bar{g}_2}{1-\delta_2} \right] \Bigg\} \cdots \Bigg\} \Bigg\}.
\end{aligned}
$$

By assumption the conditional probability that player one does not take her commitment action given that she always played a_1^* before is smaller than ε in any period from $t+1, \cdots, t+M$, so

$$(33)\qquad \sum_{a_1 \neq a_1^*} \pi^{t+i}(a_1) < \varepsilon,$$

and, of course, we can use that $\pi^{t+i}(a_1^*) \leqslant 1$. Since $\bar{g}_2$ is the maximal payoff player two can get at all, it has to be true that

$$(34)\qquad V_2^{t+i}\left(a_1, \sigma_2^{t+i}\right) \leqslant \frac{\bar{g}_2}{1-\delta_2} \quad \text{and} \quad V_2^{t+M+1} \leqslant \frac{\bar{g}_2}{1-\delta_2}.$$

Furthermore, s_2^{t+1} is supposed not to be a best response against a_1^*, so

$$(35)\qquad g_2\left(a_1^*, s_2^{t+1}\right) \leqslant \bar{g}_2.$$

Finally we can use that $g_2(a_1^*, \sigma_2) \leqslant g_2^*$. Substituting these expressions yields:

$$
\begin{aligned}
(36) \qquad V_2^{t+1}(\sigma_1, \sigma_2) - \frac{\tilde{g}_2}{1-\delta_2} &< \varepsilon \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} + 1 \\
&\quad \cdot \left\{ (\bar{g}_2 - \tilde{g}_2) + \delta_2 \cdot \varepsilon \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} \right. \\
&\quad + \delta_2 \cdot 1 \cdot \left\{ (g_2^* - \tilde{g}_2) + \cdots + \delta_2 \cdot \varepsilon \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} + \delta_2 \cdot 1 \right. \\
&\quad \left. \left. \cdot \left\{ (g_2^* - \tilde{g}_2) + \delta_2 \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} \right\} \cdots \right\} \right\} \\
&= \varepsilon \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} + \delta_2 \cdot \varepsilon \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} + \delta_2 \cdot (g_2^* - \tilde{g}_2) \\
&\quad + \cdots + \delta_2^{M-1} \cdot \varepsilon \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} + \delta_2^{M-1} \cdot (g_2^* - \tilde{g}_2) + \delta_2^M \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} \\
&= \varepsilon \cdot \left(1 + \delta_2 + \cdots + \delta_2^{M-1}\right) \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} + \delta_2^M \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} \\
&\quad + \left(1 + \delta_2 + \cdots + \delta_2^{M-1}\right) \cdot (g_2^* - \tilde{g}_2) - (g_2^* - \tilde{g}_2) \\
&< \varepsilon \cdot \frac{\bar{g}_2 - \tilde{g}_2}{(1-\delta_2)^2} + \delta_2^M \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} - (g_2^* - \tilde{g}_2) + \frac{g_2^* - \tilde{g}_2}{1-\delta_2}.
\end{aligned}
$$

Recall from the statement of Lemma 2 that

$$
(37) \qquad \varepsilon = \frac{(1-\delta_2)^2 \cdot (g_2^* - \tilde{g}_2)}{\bar{g}_2 - \tilde{g}_2} - \delta_2^M \cdot (1-\delta_2) > 0.
$$

It is easy to check that ε has been chosen such that

$$
(38) \qquad \varepsilon \cdot \frac{\bar{g}_2 - \tilde{g}_2}{(1-\delta_2)^2} + \delta_2^M \cdot \frac{\bar{g}_2 - \tilde{g}_2}{1-\delta_2} = g_2^* - \tilde{g}_2.
$$

Therefore we get

$$
(39) \qquad V_2^{t+1}(\sigma_2) - \frac{\tilde{g}_2}{1-\delta_2} < \frac{g_2^*}{1-\delta_2} - \frac{\tilde{g}_2}{1-\delta_2}.
$$

However, since g_2^* is player two's minimax payoff, this is a contradiction to the fact that we are in equilibrium. *Q.E.D.*

Proof of Proposition 1: The proof is similar to the construction of the counterexample in Section 3. Perturb the game g such that there are three types of player one, the normal type, the commitment type, and an indifferent type, whose payoff is the same for any strategy profile, with probabilities $(1-\varepsilon)$, $\varepsilon/2$, and $\varepsilon/2$, respectively. Let $\underline{\delta}_2(\varepsilon) = 2/(2+\varepsilon) < 1$ and suppose $\delta_2 > \underline{\delta}_2(\varepsilon)$. Define

$$
(40) \qquad n = \frac{\ln\left[1 - \dfrac{2(1-\delta_2)}{\delta_2 \varepsilon}\right]}{\ln \delta_2}
$$

and let $m = [n] + 2$, where $[n]$ is the integer part of n. Given the restriction on δ_2 it is straightforward to check that n is well defined and positive.

Since the commitment payoff of player one is strictly greater than her minimax payoff, there exists an action $\tilde{a}_2$ such that $\tilde{g}_1 = g_1(a_1^*, \tilde{a}_2) < g_1^*$ and $\tilde{g}_2 = g_2(a_1^*, \tilde{a}_2) < g_2^*$. Suppose that $\tilde{g}_1 >$ minmax g_1 and $\tilde{g}_2 >$ minmax g_2.[13] We will now construct an equilibrium such that the limit of the average equilibrium payoff of the normal type of player one for $\delta_1 \to 1$ is bounded away from her commitment payoff by at least η, where

$$(41) \qquad \eta = \frac{1}{m} \cdot [g_1^* - \tilde{g}_1] > 0.$$

Suppose

$$1 > \delta_1 \geqslant \sqrt{\frac{\bar{g}_1 - \tilde{g}_1}{\bar{g}_1 - \tilde{g}_1 + g_1^* - \tilde{g}_1}},$$

where $\bar{g}_1$ is the maximum payoff player one can get at all. Along the equilibrium path all types of player one play a_1^* in every period, while player two plays $a_2^* \in B(a_1^*)$ in the first $m-1$ periods, then he plays $\tilde{a}_2$ in period m, then starts again playing a_1^* for the next $m-1$ periods, and so on. If player one ever deviates from this equilibrium path, player two believes that he faces the normal type with probability 1. In this case we are essentially back in a game with complete information where the Folk Theorem tells us that any individually rational, feasible payoff vector can be sustained as a subgame perfect equilibrium. So without writing down the strategies explicitly we can construct a continuation equilibrium, such that the continuation payoff is $((1/(1-\delta_1))\tilde{g}_1, (1/(1-\delta_2))\tilde{g}_2)$. Clearly, the commitment and the indifferent type of player one have no incentive to deviate since a_1^* is at least weakly dominant for both of them. It is easy to check that—given $m \geqslant 2$ and the restriction on δ_1—the normal type of player one will not deviate either.

Now suppose player two ever deviates in any period t. In this case the normal and the commitment type are supposed to play a_1^* in period $t+1$, while the indifferent type switches to another strategy $\tilde{s}_1^{t+1} \neq a_1^*$. If player two does not observe a_1^* being played in period $t+1$, he puts probability one on the indifferent type. Using the Folk Theorem we can construct a continuation equilibrium in this subform which gives player two $(1/(1-\delta_2))\tilde{g}_2$ and which would give the normal type of player one $(1/(1-\delta_1))\tilde{g}_1$. If, however, player two observes a_1^* being played in period $t+1$ he puts probability 0 on the indifferent type. In the continuation equilibrium of this subform (a_1^*, a_2^*) are always played along the equilibrium path. If there is any deviation by player one, player two believes that he faces the normal type with probability one and—using the Folk Theorem again —the continuation payoff is $((1/(1-\delta_1))\tilde{g}_1, (1/(1-\delta_2))\tilde{g}_2)$. Clearly, always to play a_2^* is a best response of player two against always a_1^* and always a_1^* is a best response for the commitment type against any strategy. It is easy to check that it is also a best response for the normal type of player one, given the "punishment" after any deviation.

We have already shown that the strategies of the players form an equilibrium after any deviation from the equilibrium path and that, given the continuation equilibria, player one has no incentive to deviate from this path. We still have to check that player two's strategy is a best response along the equilibrium path. The best point in time for a deviation is when player two is supposed to play $\tilde{a}_2$. If it does not pay to deviate in this period, it never will. Suppose player two does not deviate. Then his payoff is given by

$$(42) \qquad V_2(\tilde{a}_2) = \tilde{g}_2 + \sum_{t=1}^{m-1} \delta_2^t g_2^* + \delta_2^m \tilde{g}_2 + \sum_{t=m+1}^{2m-1} \delta_2^t g_2^* + \cdots$$

$$= \tilde{g}_2 + \frac{\delta_2}{1-\delta_2} \cdot g_2^* - \frac{\delta_2^m}{1-\delta_2^m} \cdot (g_2^* - \tilde{g}_2).$$

However, if he deviates, the best he can do is to play a_2^* in period t. In this case his payoff is given

[13] If for any of the players $\tilde{g}_i \leqslant$ minmax g_i the construction of the "punishment equilibria" which are used below to deter any deviation from the equilibrium path is slightly more complex. In this case players have to alternate between the outcomes g^* and $\tilde{g}$ such that both get on average at least their minimax payoffs.

by

$$V_2(a_2^*) = g_2^* + \delta_2 \cdot \left\{ \left(1 - \frac{\varepsilon}{2}\right) \cdot \frac{1}{1-\delta_2} \cdot g_2^* + \frac{\varepsilon}{2} \cdot \frac{1}{1-\delta_2} \cdot \tilde{g}_2 \right\}. \tag{43}$$

It is now easy to check that ε and $\underline{\delta}(\varepsilon)$ have been constructed such that $V_2(\tilde{a}_2) > V_2(a_2^*)$. Thus we have established that this is indeed an equilibrium path.

We now have to show that along this equilibrium path the average payoff of the normal type of player one is indeed smaller than $g_1^* - \eta$ when $\delta_1 \to 1$. The equilibrium payoff of the normal type is given by

$$\begin{aligned} V_1 &= \sum_{t=1}^{m-1} \delta_1^{t-1} g_1^* + \delta_1^{m-1} \tilde{g}_1 + \sum_{t=m+1}^{2m-1} \delta_1^{t-1} g_1^* + \cdots \\ &= \frac{1}{1-\delta_1} \cdot g_1^* - \frac{1}{\delta_1} \cdot \frac{\delta_1^m}{1-\delta_1^m} \cdot [g_1^* - \tilde{g}_1]. \end{aligned} \tag{44}$$

Therefore the difference between her commitment payoff and her average payoff in this equilibrium is

$$\begin{aligned} g_1^* - (1-\delta_1) \cdot V_1 &= g_1^* - g_1^* + \frac{1-\delta_1}{\delta_1} \cdot \frac{\delta_1^m}{1-\delta_1^m} \cdot [g_1^* - \tilde{g}_1] \\ &= \frac{(1-\delta_1) \cdot \delta_1^{m-1}}{1-\delta_1^m} \cdot [g_1^* - \tilde{g}_1] \\ &= \frac{(1-\delta_1) \cdot \delta_1^{m-1}}{(1-\delta_1) \cdot \dfrac{1-\delta_1^m}{1-\delta_1}} \cdot [g_1^* - \tilde{g}_1] \\ &= \frac{\delta_1^{m-1}}{\sum_{t=0}^{m-1} \delta_1^t} \cdot [g_1^* - \tilde{g}_1] \\ &> \frac{\delta_1^{m-1}}{m} \cdot [g_1^* - \tilde{g}_1]. \end{aligned} \tag{45}$$

Taking the limit for $\delta_1 \to 1$ we get

$$\lim_{\delta_1 \to 1} \frac{\delta_1^{m-1}}{m} \cdot [g_1^* - \tilde{g}_1] = \frac{1}{m} \cdot [g_1^* - \tilde{g}_1] = \eta. \tag{46}$$

Q.E.D.

REFERENCES

AUMANN, R., AND S. SORIN (1989): "Cooperation and Bounded Recall," *Games and Economic Behavior*, 1, 5–39.

CRIPPS, M., AND J. THOMAS (1991): "Learning and Reputation in Repeated Games of Incomplete Information," mimeo, University of Warwick.

FUDENBERG, D. (1992): "Explaining Cooperation and Commitment in Repeated Games," forthcoming in *Advances in Economic Theory, Sixth World Congress*, J.-J. Laffont (ed.). Cambridge: Cambridge University Press.

FUDENBERG, D., D. KREPS, AND D. MASKIN (1990): "Repeated Games with Short-Run and Long-Run Players," *Review of Economic Studies*, 57, 555–573.

FUDENBERG, D., AND D. K. LEVINE (1989): "Reputation and Equilibrium Selection in Games with a Patient Player," *Econometrica*, 57, 759–778.

——— (1992): "Maintaining a Reputation when Strategies are Imperfectly Observed," *Review of Economic Studies*, 59, 561–579.

FUDENBERG, D., AND E. MASKIN (1986): "The Folk Theorem in Repeated Games with Discounting or with Incomplete Information," *Econometrica*, 54, 533–554.

HARSANYI, J. (1967–68): "Games with Incomplete Information Played by Bayesian Players," *Management Science*, 4, 159–182, 320–334.

HART, S. (1985): "Nonzero-Sum Two-Person Repeated Games with Incomplete Information," *Mathematics of Operations Research*, 10, 117–153.

KREPS, D., AND R. WILSON (1982): "Reputation and Imperfect Information," *Journal of Economic Theory*, 27, 253–279.

MILGROM, P., AND J. ROBERTS (1982): "Predation, Reputation and Entry Deterrence," *Journal of Economic Theory*, 27, 280–312.

RUSSELL, B. (1959): *Common Sense and Nuclear Welfare*. New York: Simon and Schuster.

SCHMIDT, K. (1993): "Commitment through Incomplete Information in a Simple Repeated Bargaining Game," *Journal of Economic Theory*, forthcoming.

SELTEN, R. (1978): "The Chain-Store Paradox," *Theory and Decision*, 9, 127–159.

Econometrica, Vol. 61, No. 3 (May, 1993)

ANNOUNCEMENTS

ACCEPTED MANUSCRIPTS

THE FOLLOWING MANUSCRIPTS, in addition to those listed in previous issues, have been accepted for publication in forthcoming issues of *Econometrica*.

DANA, ROSE ANNE: "Existence and Uniqueness of Equilibria When Preferences Are Additively Separable." (Laboratoire de Mathematiques Fondamentales, Université Pierre et Marie Curie, Tour 45-46, 3ème étage, porte 22, 4 Place Jussieu, 75252 Paris, Cedex 05, France.)

DROST, FEIKE C., AND THEO E. NIJMAN: "Temporal Aggregation of GARCH Processes." (Dept. of Econometrics, Tilburg University, P.O. Box 90153, 5000 LE Tilburg, The Netherlands.)

ERICKSON, TIMOTHY: "Restricting Regression Slopes in the Errors-in-Variables Model by Bounding the Error Correlation." (U.S. Bureau of Labor Statistics, Div. of Price & Index No. Research, Postal Square Bldg., Room 3105, 2 Massachusetts Ave. NE, Washington, DC 20212-0001.)

FAFCHAMPS, MARCEL: "Sequential Labor Decisions Under Uncertainty: An Estimable Household Model of West-African Farmers." (Food Research Institute, Stanford University, Stanford, CA 94305-6084.)

FRAYSSÉ, JEAN: "Common Agency: Existence of an Equilibrium in the Case of Two Outcomes." (GREMAQ, Université Science Sociales de Toulouse, PL Anatole France, 31042 Toulouse CE, France.)

STOCK, JAMES H., AND MARK W. WATSON: "A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems." (Dept. of Economics, Northwestern University, 2003 Sheridan Rd., Evanston, IL 60208-2600.)

Econometrica, Vol. 61, No. 3 (May, 1993)

1992 ELECTION OF FELLOWS TO THE ECONOMETRIC SOCIETY

THE FELLOWS OF THE ECONOMETRIC SOCIETY elected fifteen new Fellows in 1992. Their names and selected bibliographies are given below.

JESS BENHABIB, Professor of Economics, New York University.

"The Hopf Bifurcation and the Existence and Stability of Closed Orbits in Multisector Models of Optimal Economic Growth" (with K. Nishimura), *Journal of Economic Theory*, 21(1979), 421–444.
"Rational Choice and Erratic Behavior" (with R. H. Day), *Review of Economic Studies*, 48(1981), 459–472.
"A Characterization of Erratic Trajectories in Overlapping-Generations Models" (with R. H. Day), *Journal of Economic Dynamics and Control*, 4(1982), 37–55.
"Externalities and Growth Accounting" (with B. Jovanovic), *American Economic Review*, 81(1991), 82–113.
"Vintage Capital, Investment and Growth" (with A. Rustichini), *Journal of Economic Theory*, 55(1991), 323–339.
"Joint Exploitation of a Productive Asset: A Game Theoretic Formulation" (with R. Radner), *Economic Theory*, 2(1992), 155–190.

ANDREW S. CAPLIN, Professor of Economics, Columbia University.

"The Variability of Aggregate Demand with (S, s) Inventory Policies," *Econometrica*, 53(1985), 1395–1409.
"Menu Costs and the Neutrality of Money" (with D. Spulber), *Quarterly Journal of Economics*, 102 (1987), 129–146.
"On 64% Majority Rule" (with B. Nalebuff), *Econometrica*, 56(1988), 787–814.
"Aggregation and Imperfect Competition" (with B. Nalebuff), *Econometrica*, 59(1991), 23–59.
"State Dependent Pricing and the Dynamics of Money and Output" (with J. Leahy), *Quarterly Journal of Economics*, 106(1991).
Information, Adjustment Costs and Market Dynamics" (with J. Leahy), forthcoming in *Review of Economic Studies*.

JACQUES CREMER, Directeur de Recherche au CNRS, GREMAQ, Université des Sciences Sociales.

"A Quantity Algorithm for Planning under Increasing Returns to Scale," *Econometrica* (1977).
"A Partial Theory of the Optimal Organization of a Bureaucracy," *Bell Journal of Economics* (1980).
"Optimal Selling Strategies under Uncertainty for a Discriminating Monopolist when Demands are Interdependent" (with R. McLean), *Econometrica* (1985).
"A Sequential Solution to the Public Good Problem" (with M. Riordan), *Econometrica* (1985).
"Cooperation in Ongoing Organizations," *Quarterly Journal of Economics* (1986).
"Gathering Information before Signing a Contract" (with F. Khalil), *American Economic Review* (1992).

GENE M. GROSSMAN, Jacob Viner Professor of International Economics, Woodrow Wilson School, Princeton University.

"Optimal Trade and Industrial Policy Under Oligopoly" (with J. Eaton), *Quarterly Journal of Economics*, 101(2), May 1986, 383–406.
"Imports as a Cause of Injury: The Case of the US Steel Industry," *Journal of International Economics*, 20(3-4), May 1986, 201–233.
"Import Competition and the Stock Market Return to Capital" (with J. Levinsohn), *American Economic Review*, 79(5), December 1989, 1065–1087.
"Quality Ladders in the Theory of Growth" (with E. Helpman), *Review of Economic Studies*, 58(1), January 1991, 43–61.
Innovation and Growth in the Global Economy (with E. Helpman). Cambridge, MA: MIT Press, 1991.
"Environmental Impacts of a North American Free Trade Agreement" (with A. Krueger), Discussion Paper, Princeton University, 1991.

TAKATOSHI ITO, Professor, Institute of Economic Research, Hitotsubashi University.

"Disequilibrium Growth Theory," *Journal of Economic Theory*, 23(1980), 380–409.
"Inventory Dynamics in a Simple Disequilibrium Macroeconomic Model" (with S. Honkapohja), *Scandinavian Journal of Economics*, 82(1980), 184–198.
"Methods of Estimation for Multi-market Disequilibrium Models," *Econometrica*, 48(1980), 97–125.
"Meteor Showers or Heat Waves? Heteroskedastic Intra-daily Volatility in the Foreign Exchange Market" (with R. F. Engle and W. Lin), *Econometrica*, 58(1990), 525–542.
"Foreign Exchange Rate Expectations: Micro Survey Data," *American Economic Review*, 80(3), June 1990, 434–449.
The Japanese Economy, MIT Press, January 1992.

LAURENCE J. KOTLIKOFF, Professor of Economics, Boston University.

"The Family as an Incomplete Annuities Market" (with A. Spivak), *Journal of Political Economy*, April 1981, 372–391.
"The Role of Intergenerational Transfers in Aggregate Capital Formation" (with L. Summers), *Journal of Political Economy*, August 1981, 706–732.
Dynamic Fiscal Policy (with A. Auerbach). Cambridge: Cambridge University Press, 1987.
"The Incidence and Efficiency Costs of Corporate Taxation when Corporate and Non-Corporate Firms Produce the Same Good" (with J. Gravelle), *Journal of Political Economy*, August 1989, 749–780.
"Generational Accounts: A Meaningful Alternative to Deficit Accounting" (with A. Auerbach and J. Gokhale) in David Bradford (ed.), *Tax Policy and the Economy*, Vol. V. Cambridge: MIT Press, 1991, 55–110.
"Is the Extended Family Altruistically Linked? Direct Tests Based on Micro Data" (with J. Altonji and F. Hayashi), *American Economic Review*, December 1992, 1177–1198.

FINN E. KYDLAND, Professor of Economics, Graduate School of Industrial Administration, Carnegie Mellon University.

"Noncooperative and Dominant Player Solutions in Discrete Dynamic Games," *International Economic Review*, 16(1975), 321–335.
"Rules Rather than Discretion: The Inconsistency of Optimal Plans" (with E. C. Prescott), *Journal of Political Economy*, 85(1977), 473–491.

"Time to Build and Aggregate Fluctuations" (with E. C. Prescott), *Econometrica*, 50(1982), 1345–1370.

"Labor-Force Heterogeneity and the Business Cycle," *Carnegie-Rochester Conference Series on Public Policy*, 21(1984), 173–208.

"Intertemporal Preferences and Labor Supply" (with V. J. Hotz and G. L. Sedlacek), *Econometrica*, 56(1988), 335–360.

"International Real Business Cycles" (with D. K. Backus and P. J. Kehoe), *Journal of Political Economy*, 100(1992), 745–775.

Steven Matthews, Professor of Economics, Northwestern University.

"Selling to Risk Averse Buyers with Unobservable Tastes," *Journal of Economic Theory*, 30(August 1983), 370–400.

"Equilibrium Limit Pricing: The Effects of Private Information and Stochastic Demand" (with L. Mirman), *Econometrica*, 51(July 1983), 981–996.

"Monopoly Provision of Quality and Warranties: An Exploration in the Theory of Multidimensional Screening" (with J. Moore), *Econometrica*, 55(March 1987), 441–467.

"Comparing Auctions for Risk Averse Buyers: A Buyer's Point of View," *Econometrica*, 55(May 1987), 633–646.

"Veto Threats: Rhetoric in a Bargaining Model," *Quarterly Journal of Economics*, 104(May 1989), 347–369.

"Refining Cheap-Talk Equilibria" (with M. Okuno-Fujiwara and A. Postlewaite), *Journal of Economic Theory*, 55(December 1991), 247–273.

Bennett T. McCallum, H. J. Heinz Professor of Economics, Graduate School of Industrial Administration, Carnegie Mellon University.

"Rational Expectations and the Natural Rate Hypothesis: Some Consistent Estimates," *Econometrica*, 44(1976), 43–52.

"Rational Expectations and Macroeconomic Stabilization Policy: An Overview," *Journal of Money, Credit, and Banking*, 12(1980), 716–746.

"Price Level Determinacy with an Interest Rate Policy Rule and Rational Expectations," *Journal of Monetary Economics*, 8(1981), 319–329.

"The Role of Overlapping-Generations Models in Monetary Economics," *Carnegie-Rochester Conference Series on Public Policy*, 18(1983), 9–44.

"Are Bond-Financed Deficits Inflationary? A Ricardian Analysis," *Journal of Political Economy*, 92 (1984), 123–135.

"Robustness Properties of a Rule for Monetary Policy," *Carnegie-Rochester Conference Series on Public Policy*, 29(1988), 173–203.

Kazuo Nishimura, Professor, Institute of Economic Research, Kyoto University.

"The Hopf Bifurcation and the Existence and Stability of Closed Orbits in Multisector Models of Optimal Economic Growth" (with J. Benhabib), *Journal of Economic Theory*, 21(1979), 421–444.

"Existence of Nash Equilibrium in n-Person Games without Quasi-Concavity" (with J. Friedman), *International Economic Review*, 22(1981), 637–648.

"Kuhn's Intensity Hypothesis Revisited," *Review of Economic Studies*, 43(1981), 351–354.

"A Complete Characterization of Optimal Growth Paths in an Aggregated Model with a Non-Concave Production Function" (with D. Dechert), *Journal of Economic Theory*, 31(1983), 332–354.

"Competitive Equilibrium Cycles" (with J. Benhabib), *Journal of Economic Theory*, 35(1985), 284–306.
"Optimal Chaos, Nonlinearity and Feasibility Conditions" (with M. Yano), forthcoming in *Economic Theory*.

JAMES H. STOCK, Professor of Political Economy, Kennedy School of Government, Harvard University.

"Confidence Intervals for the Largest Autoregressive Root in U.S. Economic Time Series," *Journal of Monetary Economics*, 28(3), December 1991, 435–460.
"Pensions, the Option Value of Work, and Retirement" (with D. A. Wise), *Econometrica*, 58(5), September 1990, 1151–1180.
"Semiparametric Estimation of Index Coefficients" (with J. Powell and T. Stoker), *Econometrica*, 57(6), November 1989, 1403–1430.
"New Indexes of Coincident and Leading Economic Indicators" (with M. W. Watson), *NBER Macroeconomics Annual*, 1989, 351–393.
"Measuring Business Cycle Time," *Journal of Political Economy*, 95(6), December 1987, 1240–1261.
"Asymptotic Properties of Least Squares Estimators of Cointegrating Vectors," *Econometrica*, 55(5), September 1987, 1035–1056.

JACQUES-FRANÇOIS THISSE, Professor of Economics, CORE and Université de Paris I-Sorbonne.

"Price Competition, Quality and Income Disparities" (with J.-J. Gabszewicz), *Journal of Economic Theory*, 20(1979), 340–359.
"On Hotteling's 'Stability in Competition'" (with C. d'Aspremont and J.-J. Gabszewicz), *Econometrica*, 47(1979), 1145–1150.
"Entry (and Exit) in a Differentiated Industry" (with J.-J. Gabszewicz), *Journal of Economic Theory*, 22(1980), 327–338.
"On the Strategic Choice of Spatial Price Policy" (with X. Vives), *American Economic Review*, 78(1988), 122–137.
"Demand for Differentiated Products, Discrete Choice Models, and the Characteristics Approach" (with S. Anderson and A. de Palma), *Review of Economic Studies*, 56(1989), 21–35.
"On the Optimality of Central Places" (with M. Quinzii), *Econometrica*, 58 (1990), 1101–1119.

XAVIER VIVES, Professor of Economics, Institut d'Anàlisi Econòmica (CSIC), Campus Universitat Autònoma de Barcelona.

"Duopoly Information Equilibrium: Cournot and Bertrand," *Journal of Economic Theory*, 34(1984), 71–94.
"Small Income Effects: A Marshallian Theory of Consumer Surplus and Downward Sloping Demand," *Review of Economic Studies*, 54(1987), 87–103.
"On the Strategic Choice of Spatial Price Policy" (with J.-F. Thisse), *American Economic Review*, 78(1988), 122–137.
"Aggregation of Information in Large Cournot Markets," *Econometrica*, 56(1988), 851–876.
"Nash Equilibrium with Strategic Complementarities," *Journal of Mathematical Economics*, 19(1990), 305–321.
"How Fast Do Rational Agents Learn?" forthcoming in *Review of Economic Studies*, 1993.

MARK W. WATSON, Professor of Economics, Northwestern University.

"A One-Factor Multivariate Time Series Model of Metropolitan Wage Rates" (with R. F. Engle), *Journal of the American Statistical Association*, 76(376), 1981, 774–781.
"Are Business Cycles All Alike?" (with O. J. Blanchard), in Robert J. Gordon (ed.), *The American Business Cycle*, NBER and Chicago Press, 1986.
"Univariate Detrending with Stochastic Trends," *Journal of Monetary Economics*, 18(June 1986), 49–75.
"Testing for Common Trends" (with J. H. Stock), *Journal of the American Statistical Association*, 83(December 1988), 1097–1107.
"Inference in Linear Time Series Models with Some Unit Roots" (with C. A. Sims and J. H. Stock), *Econometrica*, 58(1), January 1990, 113–144.
"Stochastic Trends and Economic Fluctuations" (with R. King, C. Plosser, and J. H. Stock), *American Economic Review*, 81(4), September 1991, 819–840.

SHMUEL ZAMIR, Professor, Department of Statistics, The Hebrew University.

"The Value of Two-Person Zero-Sum Repeated Games with Incomplete Information" (with J. F. Mertens), *International Journal of Game Theory*, 1(1), 1971, 39–64.
"On the Notion of Value for Games with Infinitely Many Stages," *Annals of Statistics*, 1(4), 1973, 791–798.
"Existence of Approximate Equilibria and Cores" (with W. Hildenbrand and D. Schmeidler), *Econometrica*, 41(6), 1974, 1159–1166.
"Repeated Games of Incomplete Information: The Symmetric Case" (with E. Kohlberg), *Annals of Statistics*, 2(5), 1974, 1040–1041.
"Formulation of Bayesian Analysis for Games with Incomplete Information" (with J. F. Mertens), *International Journal of Game Theory*, 14(1), 1985, 1–29.
"On the Value of Information in a Strategic Conflict" (with M. Kamien and Y. Tauman), *Games and Economic Behavior*, 2(1990), 129–153.

Econometrica, Vol. 61, No. 3 (May, 1993)

FELLOWS OF THE ECONOMETRIC SOCIETY
JANUARY 1993

(*) Indicates a Fellow who is not a current member of the Society

ANDREW B. ABEL, Department of Finance, Wharton School, University of Pennsylvania, 3620 Locust Walk, Philadelphia, Pennsylvania 19104-6367 (1991).

DILIP ABREU, Department of Economics, Princeton University, Princeton, New Jersey 08544 (1991).

IRMA ADELMAN, College of Agriculture, University of California—Berkeley, Berkeley, California 94720 (1968).

(*) SYDNEY N. AFRIAT, Department of Economics, University of Ottawa, Ottawa, Ontario, K1N 6N5, Canada (1976).

ABEL GESEVICH AGANBEGYAN, Economic Department of the USSR, Academy of Sciences, Krasikova St. 32, Moscow 117 418, Russia (1978).

DENNIS J. AIGNER, Graduate School of Management, University of California—Irvine, Irvine, California 92717 (1975).

(*) GEORGE AKERLOF, Department of Economics, University of California—Berkeley, Berkeley, California 94720 (1979).

(*) MAURICE ALLAIS, Ecole Nationale Supérieure des Mines de Paris, Paris, France (1949).

BETH E. ALLEN, Department of Economics, University of Minnesota, Minneapolis, Minnesota 55455 (1983).

TAKESHI AMEMIYA, Department of Economics, Stanford University, Stanford, California 94305 (1974).

ROBERT M. ANDERSON, Department of Economics, 787 Evans Hall, University of California—Berkeley, Berkeley, California 94720 (1987).

T. W. ANDERSON, Department of Statistics, Sequoia Hall, Stanford University, Stanford, California 94305 (1950).

ALBERT K. ANDO, Department of Economics, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (1966).

DONALD W. K. ANDREWS, Cowles Foundation, Yale University, P.O. Box 2125 Yale Station, New Haven, Connecticut 06520-2125 (1989).

MASAHIKO AOKI, Department of Economics, Stanford University, Stanford, California 94305-6072 (1981).

MASANAO AOKI, Department of Economics, 405 Hilgard Avenue, University of California—Los Angeles, Los Angeles, California 90024-1477 (1978).

ALOISIO ARAUJO, IMPA, Edificio Lelio Gama, Estrada Dona Castorina, 110, Jardim Botanico, CEP 22, 460, Rio de Janeiro, Brazil (1987).

(*) G. CHRISTOPHER ARCHIBALD, Department of Economics, University of British Columbia, Vancouver, British Columbia, V6T 1W5, Canada (1976).

KENNETH J. ARROW, Department of Economics, Stanford University, Stanford, California 94305 (1951).

ORLEY ASHENFELTER, Industrial Relations Section, Firestone Library, Princeton University, Princeton, New Jersey 08544-2098 (1977).

(*) CLAUDE D'ASPREMONT, CORE, 34 Voie du Roman Pays, B-1348 Louvain-la-Neuve, Belgium (1984).

A. B. ATKINSON, Department of Economics, London School of Economics, Houghton Street, Aldwych, London WC2A 2AE, England (1974).

ALAN AUERBACH, Department of Economics, University of Pennsylvania, 3718 Locust Walk/CR, Philadelphia, Pennsylvania 19104 (1986).

MARIA AUGUSTINOVICS, Institute of Economics, Hungarian Academy of Science, Budapest ut 43-45, Budapest, XI, 1112 Hungary (1979).

ROBERT AUMANN, Institute of Mathematics and Computer Science, The Hebrew University, Givat Ram, Jerusalem, 91904 Israel (1965).

COSTAS AZARIADIS, Department of Economics, 3718 Locust Walk, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6297 (1989).

(*) YVES BALASKO, Department of Econometrics, University of Geneva, 2, rue Dancet, 1211 Geneva 4, Switzerland (1980).

PIETRA BALESTRO, 1, Chemin du Cerisier, Corsier 1246, Switzerland (1971).

R. J. BALL, London Graduate School of Business, Sussex Place, Regents Park, London NW1, England (1973).

SALVADOR BARBERA, Department d'Economia i Historia Economica, Universitat Autonoma de Barcelona, 08193 Bellaterra, Barcelona, Spain (1988).

(*) T. BARNA, Beanacre Westmeston, Hassocks, Sussex BN6 8XE, England (1952).

DAVID P. BARON, Graduate School of Business, Stanford University, Stanford, California 94305-5015 (1990).

(*) ROBERT J. BARRO, Department of Economics, Littauer Center, Harvard University, Cambridge, Massachusetts 02138 (1980).

A. P. BARTEN, Rotspoelstraat 117, B-3030 Leuven, Belgium (1968).

ROBERT L. BASMANN, Department of Economics, SUNY, Binghamton, New York 13901 (1966).

KAUSHIK BASU, Delhi School of Economics, University of Delhi, Delhi 110 007, India (1991).

WILLIAM J. BAUMOL, Department of Economics, Princeton University, Princeton, New Jersey 08540 (1953).

GARY S. BECKER, Department of Economics, University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637 (1967).

MARTIN J. BECKMANN, Department of Economics, Brown University, Providence, Rhode Island 02912 (1958).

JERE R. BEHRMAN, Department of Economics, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (1980).

JEAN-PASCAL BENASSY, CNRS and CEPREMAP, 142 rue du Chevaleret, 75013 Paris, France (1981).

JESS BENHABIB, Department of Economics, New York University, 269 Mercer Street, New York, New York 10003 (1992).

(*) RAGNAR BENTZEL, Department of Economics, University of Uppsala, Box 513, S 751 20 Uppsala, Sweden (1970).

(*) ABRAM BERGSON, Department of Economics, Littauer Center, Harvard University, Cambridge, Massachusetts 02138 (1949).

ALBERT BERGSTROM, Department of Economics, University of Essex, Wivenhoe Park, Colchester, England (1971).

B. DOUGLAS BERNHEIM, Department of Economics, Princeton University, Princeton, New Jersey 08544-1021 (1991).

TRUMAN F. BEWLEY, Cowles Foundation for Research in Economics, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520-2125 (1978).

JAGDISH BHAGWATI, International Economic Research Center, Columbia University, Box 22, International Affairs Building, New York, New York 09403-1617 (1973).

KENNETH BINMORE, Economics Department, University College London, Gower Street, London WC1, United Kingdom (1987).

CHARLES BLACKORBY, Department of Economics, University of British Columbia, 997-1873 East Mall, Vancouver, British Columbia, V6T 1W5, Canada (1988).

OLIVIER BLANCHARD, Department of Economics, E52-252A, 50 Memorial Drive, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1985).

(*) Alan S. Blinder, Department of Economics, Princeton University, Princeton, New Jersey 08540 (1981).

C. J. Bliss, Department of Economics, Nuffield College, Oxford University, Oxford OX1 1NF, England (1975).

Richard Blundell, Department of Economics, University College London, Gower Street, London WC1E 6BT, England (1991).

Marcel Boiteux, Honorary Chairman, Electricité de France, 26 rue de la Baume, 75008 Paris, France (1953).

François Bourguignon, DELTA, E.N.S., 48 boulevard Jourdan, 75014 Paris, France (1986).

William C. Brainard, Cowles Foundation for Research in Economics, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1975).

(*) Timothy F. Bresnahan, Department of Economics, Encina Hall, Stanford University, Stanford, California 94305-6072 (1990).

Trevor S. Breusch, Department of Statistics, Australian National University, Canberra, ACT 2601, Australia (1991).

William A. Brock, Department of Economics, University of Wisconsin-Madison, Madison, Wisconsin 53706 (1974).

Andras Brody, Institute of Economics, Hungarian Academy of Science, 1361 Budapest, Hungary (1971).

(*) Donald Brown, Department of Economics, Yale University, 28 Hillhouse Avenue, New Haven, Connecticut 06520 (1981).

Michael Bruno, Department of Economics, The Hebrew University, Mount Scopus, Jerusalem 91905, Israel (1967).

Jeremy I. Bulow, Graduate School of Business, Stanford University, Stanford, California 94305-5015 (1990).

Edwin Burmeister, Department of Economics, 305 Social Sciences Building, Duke University, Durham, North Carolina 27701 (1978).

(*) Phillip D. Cagan, Department of Economics, Columbia University, New York, New York 10027 (1975).

John Y. Campbell, Department of Economics, Princeton University, Princeton, New Jersey 08544 (1990).

Andrew S. Caplin, Department of Economics, Columbia University, 420 West 118th Street, New York, New York 10027 (1992).

David Card, Department of Economics, Princeton University, Princeton, New Jersey 08544 (1991).

Anne Carter, 202 Brattle Street, Cambridge, Massachusetts 02138 (1973).

David Cass, Department of Economics, University of Pennsylvania, 3718 Locust Walk CR, Philadelphia, Pennsylvania 19104 (1972).

Gary Chamberlain, Department of Economics, Harvard University, Cambridge, Massachusetts 02138 (1981).

(*) Paul Champsaur, Direction de la Prevision, 151, rue Saint Honore, 75056 Paris, France (1981).

Abraham Charnes, Director, Center for Cybernetic Studies, University of Texas-Austin, CBA 5.202, Austin, Texas 78712-1177 (1959).

Hollis Chenery, 5 Hemlock Road, Cambridge, Massachusetts 02138 (1958).

John Chipman, 1035 Management and Economics Building, University of Minnesota, 271 19th Avenue South, Minneapolis, Minnesota 55455 (1956).

Gregory C. Chow, Department of Economics, Princeton University, 206 Fisher Hall, Princeton, New Jersey 08544 (1967).

Carl Christ, Department of Political Economy, Johns Hopkins University, Baltimore, Maryland 21218 (1967).

(*) Robert W. Clower, Department of Economics, University of South Carolina, Columbia, South Carolina 29208 (1978).

W. W. Cooper, Department of Management, School of Business, University of Texas-Austin, Austin, Texas 78712 (1957).

John C. Cox, Sloan School of Management, 50 Memorial Drive E52-476, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139-4307 (1990).

Jan Solomon Cramer, Baambrugse Zuwe 194, 3645 Am Vinkeveen, The Netherlands (1972).

Vincent P. Crawford, Department of Economics, D-008, University of California—San Diego, La Jolla, California 92093 (1990).

Jacques Cremer, Directeur de Recherche au CNRS, GREMAQ, Université des Sciences Sociales, Place Anatole France, 31042 Toulouse Cedex, France (1992).

Richard M. Cyert, Department of Economics, Carnegie-Mellon University, 5000 Forbes Avenue, Pittsburgh, Pennsylvania 15213 (1977).

George C. Dantzig, Department of Operations Research, Stanford University, Stanford, California 94305 (1953).

(*) Partha Dasgupta, Faculty of Economics and Politics, University of Cambridge, Sidgwick Avenue, Cambridge CB3 9DD, England (1975).

(*) Paul A. David, Department of Economics, Stanford University, Stanford, California 94305 (1975).

Otto A. Davis, Department of Social Sciences, Carnegie-Mellon University, Margaret Morrison Carnegie College, Pittsburgh, Pennsylvania 15213 (1978).

Richard H. Day, Department of Economics, University of Southern California, Los Angeles, California 90089-0035 (1991).

Angus S. Deaton, Woodrow Wilson School of Public and International Affairs, Princeton University, Princeton, New Jersey 08544 (1978).

Gerard Debreu, Department of Economics, University of California—Berkeley, Berkeley, California 94720 (1954).

Gabrielle Demange, Directeur d'Etudes EHESS, DELTA, 48 Boulevard Jourdan, 75014 Paris, France (1991).

Phoebus Dhrymes, 107 White Plains Road, Bronxville, New York 10708 (1970).

Douglas W. Diamond, Graduate School of Business, 1101 East 59th Street, University of Chicago, Chicago, Illinois 60637 (1990).

Peter A. Diamond, Department of Economics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1968).

Egbert Dierker, Department of Economics, University of Vienna, Dr. Karl Lueger-Ring 1, A-1010 Vienna, Austria (1986).

W. E. Diewert, Department of Economics, University of British Columbia, Vancouver 8, British Columbia, V6T 1W5, Canada (1975).

A. K. Dixit, Department of Economics, Princeton University, Princeton, New Jersey 08544-1021 (1977).

(*) Evsey D. Domar, Department of Economics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1968).

(*) Robert Dorfman, Department of Economics, Harvard University, Cambridge, Massachusetts 02138 (1955).

Rudiger Dornbusch, Department of Economics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1978).

Jacques Drèze, Research Director of CORE, 34, Voie du Roman Pays, B-1348 Louvain-la-Neuve, Belgium (1965).

Pradeep Dubey, Department of Applied Math and Statistics, SUNY at Stony Brook, Stony Brook, New York 11794 (1990).

(*) J. S. Duesenberry, Department of Economics, Harvard University, Cambridge, Massachusetts 02138 (1966).

(*) James Durbin, London School of Economics, 31 Southway, London NW11 6RX, United Kingdom (1967).

RICHARD A. EASTERLIN, Department of Economics MRG, University of California—Los Angeles, Los Angeles, California 90089-0152 (1982).

ROBERT EISNER, Department of Economics, Northwestern University, Evanston, Illinois 60208-2600 (1962).

ROBERT F. ENGLE III, Department of Economics, D-008, University of California—San Diego, 9500 Gillman Drive, San Diego, California 92093 (1981).

LARRY G. EPSTEIN, Department of Economics, University of Toronto, 150 St. George Street, Toronto, Ontario, M5S 1A1, Canada (1989).

WILFRED J. ETHIER, Department of Economics, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6297 (1991).

RAY C. FAIR, Cowles Foundation for Research in Economics, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1977).

EUGENE FAMA, Graduate School of Business, University of Chicago, Chicago, Illinois 60637 (1973).

HENRY S. FARBER, Princeton University, Industrial Relations Section, Firestone Library, Princeton, New Jersey 08544-2098 (1988).

(*) NIKOLAI P. FEDORENKO, Director of TSEMI-Academy of Sciences USSR, 32 Krasikova Street, Moscow B-418, Russia (1971).

MARTIN FELDSTEIN, Department of Economics, Harvard University, Cambridge, Massachusetts 02138 (1970).

STANLEY FISCHER, Department of Economics, Room E52-280A, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1977).

PETER C. FISHBURN, Economics Research Center, Bell Laboratories, Murray Hill, New Jersey 07974 (1974).

FRANKLIN M. FISHER, Department of Economics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1963).

(*) WALTER D. FISHER, Department of Economics, Northwestern University, Evanston, Illinois 60208-2600 (1967).

ROBERT W. FOGEL, Graduate School of Business, University of Chicago, Chicago, Illinois 60637 (1970).

KARL A. FOX, 234 Parkridge Circle, Ames, Iowa 50010 (1959).

(*) JACOB A. FRENKEL, Governor, Bank of Israel, P.O. Box 780, Jerusalem 91907, Israel (1982).

JAMES W. FRIEDMAN, Department of Economics, University of North Carolina, Chapel Hill, North Carolina 27514 (1977).

(*) MILTON FRIEDMAN, The Hoover Institution, Stanford University, Stanford, California 94305 (1949).

DREW FUDENBERG, Department of Economics, E52-380B, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1987).

JEAN JASKOLD GABSZEWICZ, CORE, 34 Voie du Roman Pays, B-1348 Louvain-la-Neuve, Belgium (1979).

(*) DAVID GALE, Department of Economics, University of California, Berkeley, Berkeley, California 94720 (1965).

DOUGLAS M. GALE, Department of Economics, College of Liberal Arts, 270 Bay State Road, Boston University, Boston, Massachusetts 02215 (1987).

A. RONALD GALLANT, Department of Statistics, North Carolina State University, P.O. Box 8203, Raleigh, North Carolina 27695-8203 (1985).

JOHN GEANAKOPLOS, Cowles Foundation, Yale University, Box 2125, Yale Station, New Haven, Connecticut 06520 (1989).

(*) N. GEORGESCU-ROEGEN, Vanderbilt University, Box 1816, Station B, Nashville, Tennessee 37235 (1950).

LOUIS-ANDRÉ GÉRARD-VARET, GREQE-EHESS, Hospice de la Vieille Charité, 2, rue de la Charité, F-13002 Marseille, France (1990).

LOUIS GEVERS, Faculté des Sciences Economiques, Rempart de la Vierge 8, B-5000 Namur, Belgium (1986).

JOHN F. GEWEKE, University of Minnesota, 1035 Management & Economics Bldg., 271 19th Avenue South, Minneapolis, Minnesota 55455 (1982).

ALLAN GIBBARD, Department of Philosophy, University of Michigan, 2209 Angell Hall, Ann Arbor, Michigan 48109-1003 (1984).

(*) ROBERT GILBRAT, 105 rue du Ranelagh, 75016 Paris, France (1948).

ARTHUR S. GOLDBERGER, Department of Economics, University of Wisconsin, Madison, Wisconsin 53706 (1964).

STEPHEN M. GOLDFELD, Department of Economics, Princeton University, Princeton, New Jersey 08540 (1973).

CLAUDIA GOLDIN, Department of Economics, 316 Littauer Center, Harvard University, Cambridge, Massachusetts 02138 (1991).

(*) RALPH E. GOMERY, President, Alfred P. Sloan Foundation, 630 5th Avenue, Suite 2550, New York, New York 10111-0242 (1972).

(*) RICHARD M. GOODWIN, Cambridge University, Peterhouse College, Cambridge, England (1951).

ROBERT J. GORDON, Department of Economics, Northwestern University, Evanston, Illinois 60208-2600 (1977).

W. M. GORMAN, Nuffield College, Oxford University, Oxford OX1 1NF, England (1961).

CHRISTIAN GOURIEROUX, CEPREMAP, 142 rue du Chevaleret, 75013 Paris, France (1986).

JEAN-MICHEL GRANDMONT, CNRS and CEPREMAP, 140 rue du Chevaleret, 75013 Paris, France (1974).

C. W. J. GRANGER, Department of Economics, University of California—San Diego, La Jolla, California 92093 (1972).

EDWARD J. GREEN, Department of Economics, 1035 Management and Economics, 271 19th Avenue South, University of Minnesota, Minneapolis, Minnesota 55455 (1987).

JERRY R. GREEN, Provost, Massachusetts Hall, Harvard University, Cambridge, Massachusetts 02138 (1975).

ZVI GRILICHES, Department of Economics, Littauer Center, Rm. 125, Harvard University, Cambridge, Massachusetts 02138 (1964).

BIRGIT GRODAL, Institute of Economics, University of Copenhagen, Studiestraede 6, DK-1455, Copenhagen K, Denmark (1981).

REUBEN GRONAU, Hebrew University of Jerusalem, Mount Scopus, Jerusalem 91905, Israel (1986).

GENE M. GROSSMAN, Woodrow Wilson School of Public and International Affairs, Princeton University, Princeton, New Jersey 08544-1013 (1992).

SANFORD GROSSMAN, The Wharton School, Finance Department, 3620 Locust Walk, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6377 (1980).

THEODORE F. GROVES, JR., Department of Economics, D-008, University of California—San Diego, 9500 Gilman Drive, La Jolla, California 92093 (1977).

ROGER GUESNERIE, DELTA, CNRS and EHESS, E.N.S. 48, Boulevard Jourdan, 75014 Paris, France (1980).

(*) G. T. GUILBAUD, Ecole des Hautes Etudes en Sciences Sociales, Department of Mathematics, 54, Boulevard Raspail, 75006 Paris, France (1951).

TRYGVE HAAVELMO, University Institute of Economics, Box 1095 Blindern, Oslo 3, Norway (1944).

(*) GOTTFRIED HABERLER, Financial Section, League of Nations, Geneva, Switzerland (1933).

FRANK H. HAHN, Faculty of Economics and Politics, Cambridge University, Sidgwick Avenue, Cambridge CB3 9DD, England (1961).

ROBERT E. HALL, Department of Economics, Stanford University, Stanford, California 94305 (1973).

KOICHI HAMADA, Department of Economics, Economic Growth Center, 27 Hillhouse Avenue, Yale University, New Haven, Connecticut 06520 (1978).

PETER J. HAMMOND, Department of Economics, Stanford University, Stanford, California 94305 (1977).

EDWARD J. HANNAN, Department of Statistics, Institute for Advanced Studies, Australian National University, Canberra, Australia (1966).

GIORA HANOCH, Department of Economics, The Hebrew University, Jerusalem, Israel 91905 (1975).

BENT HANSEN, Department of Economics, University of California—Berkeley, Berkeley, California 94720 (1958).

LARS PETER HANSEN, Department of Economics, University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637 (1984).

ARNOLD HARBERGER, Department of Economics, University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637 (1967).

MILTON HARRIS, Graduate School of Business, University of Chicago, 1101 East 58th Street, Chicago, Illinois 60637 (1988).

(*) JOHN C. HARSANYI, School of Business Administration, University of California—Berkeley, Berkeley, California 94720 (1968).

OLIVER HART, Department of Economics, E52-252D, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1979).

SERGIU HART, Department of Economics, The Hebrew University, Mount Scopus, 91905 Jerusalem, Israel (1985).

ANDREW C. HARVEY, Statistics Department, London School of Economics, Houghton Street, London WC2A 2AE, England (1990).

MICHIO HATANAKA, 16-13 Machikaneyama-cho, Toyonaka-shi, Osaka, 560 Japan (1974).

JERRY A. HAUSMAN, Department of Economics, E52-271A, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1979).

FUMIO HAYASHI, Department of Economics, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (1988).

GEOFFREY MARTIN HEAL, School of Business, Uris Hall, Columbia University, New York, New York 10027 (1977).

JAMES J. HECKMAN, Department of Economics, University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637 (1972).

MARTIN F. HELLWIG, Institut fur Volkswirtschaft, University of Basel, Petersgraben 51, Postfach CH-4003, Basel, Switzerland (1981).

ELHANAN HELPMAN, Department of Economics, Littauer Center, Harvard University, Cambridge, Massachusetts 02138 (1986).

DAVID HENDRY, Department of Economics, Nuffield College, Oxford University, Oxford OX1 1NF, England (1975).

CLAUDE HENRY, Laboratoire d'èconometriè, Ecole Polytechnique, 17 rue Descartes, 75 Paris 5, France (1976).

DONALD D. HESTER, Department of Economics, University of Wisconsin-Madison, Madison, Wisconsin 53706 (1976).

BERT G. HICKMAN, Department of Economics, Stanford University, Stanford, California 94305 (1977).

WERNER HILDENBRAND, Department of Economics G + W II, University of Bonn, Adenauerallee 24-26, W-5300 Bonn 1, Germany (1971).

(*) CLIFFORD HILDRETH, Center for Economic Research, University of Minnesota, Minneapolis, Minnesota 55455 (1953).

JACK HIRSHLEIFER, Department of Economics, University of California—Los Angeles, Los Angeles, California 90024 (1985).

(*) CHARLES J. HITCH, 1515 Oxford Street, Berkeley, California 94709 (1968).

ALBERTO HOLLY, Département d'économétrie et d'economie politique (DEEP), Université de Lausanne, Ecole des H.E.C., BESH 1015, Lausanne, Switzerland (1985).

BENGT ROBERT HOLMSTROM, Yale School of Organization and Management, Box 1A, New Haven, Connecticut 06520 (1983).

CHARLES C. HOLT, College of Business Administration, The University of Texas-Austin, Austin, Texas 78712 (1973).

(*) WILLIAM C. HOOD, 601 Windermere Avenue, Ottawa, Ontario, Canada (1975).

H. S. HOUTHAKKER, Department of Economics, 209 Littauer Center, Harvard University, Cambridge, Massachusetts 02138 (1952).

LEONID HURWICZ, Department of Economics, 1035 Management & Economics Bldg., University of Minnesota, Minneapolis, Minnesota 55455 (1947).

SHINICHI ICHIMURA, Osaka International University, 1-50 Sugi 3-Chrome Hirakata, Osaka-Fu 573-01, Japan (1962).

(*) KEN-ICHI INADA, Institute for Social and Economic Research, Osaka University, Toyonaku Osaka, Japan (1968).

MICHAEL D. INTRILIGATOR, Department of Economics, University of California—Los Angeles, Los Angeles, California 90024 (1982).

TAKATOSHI ITO, Institute of Economic Research, Hitotsubashi University, Kunitachi, Tokyo 186, Japan (1992).

JOHN JOHNSTON, School of Social Sciences, University of California—Irvine, Irvine, California 92717 (1963).

(*) RONALD W. JONES, Department of Economics, University of Rochester, Rochester, New York 14627 (1971).

JAMES J. JORDAN, JR., Department of Economics, University of Minnesota, Minneapolis, Minnesota 55455 (1980).

DALE W. JORGENSON, Department of Economics, 122 Littauer Center, Harvard University, Cambridge, Massachusetts 02138 (1964).

PAUL L. JOSKOW, Department of Economics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1988).

BOYAN JOVANOVIC, Department of Economics, New York University, 269 Mercer Street, New York, New York 10003 (1989).

KENNETH L. JUDD, Hoover Institution, HHMB-Room 334, Stanford, California 94305 (1989).

GEORGE G. JUDGE, 207 Giannini Hall, University of California—Berkeley, Berkeley, California 94720 (1986).

EHUD KALAI, MEDS Department, J. L. Kellogg Graduate School of Management, Northwestern University, Evanston, Illinois 60208-2001 (1988).

JAKAR KANNAI, Department of Theoretical Mathematics, The Weizmann Institute of Science, Rehovot, Israel (1978).

TIMOTHY J. KEHOE, 1035 Management & Economics, 271 19th Avenue South, University of Minnesota, Minneapolis, Minnesota 55455-0430 (1991).

MURRAY C. KEMP, School of Economics, P.O. Box 1, University of New South Wales, Kensington, New South Wales, Australia (1971).

NICHOLAS KIEFER, Department of Economics, Cornell University, Uris Hall, 4th Floor, Ithaca, New York 14853 (1989).

RICHARD KIHLSTROM, Department of Finance, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (1979).

MERVYN A. KING, Chief Economist & Executive Director, Bank of England, Threadneedle Street, London EC2R 8AH, England (1982).

ALAN P. KIRMAN, Department of Economics, European University Institute, Badia Fiesolana, 50016 San Domenico (FI), Italy (1990).

LAWRENCE R. KLEIN, Department of Economics, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (1948).

Teun Kloek, Econometric Institute, Erasmus University, P.O. Box 1738 3000 DR, Rotterdam, The Netherlands (1978).
Jan Kmenta, Department of Economics, University of Michigan, Ann Arbor, Michigan 48109 (1980).
Elon Kohlberg, Morgan Hall, Room 303, Harvard Business School, Soldiers Field, Boston, Massachusetts 02163-1700 (1991).
Serge-Christophe Kolm, CERAS-EMPC, 20 Rue Henri-Heine, 75106 Paris, France (1973).
Heinz König, University of Mannheim, Seminargebaude A-5, D-6800 Mannheim 1, Germany (1986).
Janos Kornai, Institute of Economics, Hungarian Academy of Sciences, Budaorsi ut 45, 1112 Budapest, Hungary (1968).
Laurence J. Kotlikoff, Department of Economics, Boston University, 270 Bay State Road, Boston, Massachusetts 02215 (1992).
(*) Irving B. Kravis, Department of Economics, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (1979).
Wilhelm Krelle, Am Domblick 15, W-5300 Bonn-Bad Godesberg, Germany (1963).
David M. Kreps, Graduate School of Business, Stanford University, Stanford, California 94305 (1981).
Anne O. Krueger, Department of Economics, Duke University, Durham, North Carolina 27706 (1981).
Paul R. Krugman, Department of Economics, E52-383A, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1986).
Harold W. Kuhn, Department of Mathematics, Fine Hall, Box 37, Princeton University, Princeton, New Jersey 08544 (1961).
Mordecai Kurz, Department of Economics, Encina Hall, 4th Floor, Stanford University, Stanford, California 94305 (1970).
Finn E. Kydland, Graduate School of Industrial Administration, Carnegie-Mellon University, Schenley Park, Pittsburgh, Pennsylvania 15213 (1992).
Jean-Jacques Laffont, Institut D'Economie Industrielle, Université des Sciences Sociales de Toulouse, Place Anatole France, F-31042 Toulouse Cedex, France (1978).
Anthony Lancaster, Department of Economics, Brown University, Providence, Rhode Island 02912 (1991).
Kelvin J. Lancaster, Department of Economics, Columbia University, New York, New York 10027 (1972).
Guy Laroque, INSEE—Départment de la Recherche, 18, Boulevard Adolphe Pinard, 75675 Paris, Cedex 14, France (1979).
Lawrence J. Lau, Department of Economics, Stanford University, Stanford, California 94305 (1976).
Richard Layard, Centre for Labour Economics, London School of Economics, Houghton Street, London WC2A 2AE, England (1986).
Edward Lazear, Graduate School of Business, Stanford University, Stanford, California 94305 (1988).
Edward E. Leamer, Department of Economics, University of California, Los Angeles, 405 Hilgard Avenue, Los Angeles, California 90024 (1977).
John O. Ledyard, Division of Humanities and Social Science, California Institute of Technology, Pasadena, California 91125 (1977).
Lung-fei Lee, Department of Economics, University of Michigan, Ann Arbor, Michigan 48109-1220 (1990).
(*) Wassily Leontief, Institute of Economic Analysis, 269 Mercer St., 2nd Floor, New York University, New York, New York 10003 (1939).
Jacques Lesourne, 52, Rue de Vaugirard, 75006, Paris, France (1967).
(*) David Levhari, Department of Economics, The Hebrew University, Jerusalem, Israel (1970).

DAVID K. LEVINE, Department of Economics, University of California—Los Angeles, 405 Hilgard Avenue, Los Angles, California 90024 (1989).

ASSAR LINDBECK, Institute for International Economic Studies, University of Stockholm, S-10405, Stockholm, Sweden (1973).

RICHARD G. LIPSEY, Continuing Studies, Simon Fraser University, Harbour Centre, 515 Hastings Street, Vancouver, British Columbia V6B 5K3, Canada (1972).

(*) NISSAN LIVIATAN, Falk Project for Economic Research, Jerusalem, Israel (1966).

MICHAEL C. LOVELL, Department of Economics, Wesleyan University, Middletown, Connecticut 06457 (1980).

ROBERT E. LUCAS JR., Department of Economics, University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637 (1975).

(*) HAROLD F. LYDALL, Institute of Economics and Statistics, Manor Road, Oxford OX1 3UL, England (1980).

MARK J. MACHINA, Department of Economics, University of California—San Diego, La Jolla, California 92093 (1989).

JAMES G. MACKINNON, Department of Economics, Queen's University, Kingston, Ontario, K7L 3N6, Canada (1990).

THOMAS E. MACURDY, Department of Economics, Stanford University, Stanford, California 94305 (1987).

(*) ALBERT MADANSKY, Graduate School of Business, University of Chicago, Chicago, Illinois 60637 (1977).

G. S. MADDALA, Center for Econometrics and Decision Sciences, University of Florida, Gainesville, Florida 32611 (1975).

JACQUES MAIRESSE, 9 Avenue de l'Observatoire, 75006 Paris, France (1986).

MUKUL MAJUMDAR, Department of Economics, Cornell University, Uris Hall 4th Floor, Ithaca, New York 14853 (1976).

VALERY L. MAKAROV, Central Economic-Mathematical Institute, The USSR Academy of Sciences, Krasikova str. 32, 117418 Moscow, Russia (1978).

EDMOND MALINVAUD, Collège de France, 3, Rue d'Ulm, 75005 Paris, France (1955).

(*) SVEN MALMQUIST, Institut of Statistics, University of Stockholm, S-10691 Stockholm, Sweden (1955).

(*) BENOIT B. MANDELBROT, P.O. Box 218, Yorktown Heights, New York 10598 (1967).

(*) ALAN S. MANNE, Department of Operations Research, Stanford University, Stanford, California 94305 (1960).

EDWIN MANSFIELD, Department of Economics, Wharton School of Business, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (1970).

CHARLES F. MANSKI, Department of Economics, University of Wisconsin, Madison, Wisconsin 53706 (1984).

ROLF R. MANTEL, Universidad De San Andres, Arias 3100 y Vito Dumas, 1644, Victoria, Prov BS AS, Buenos Aires, Argentina (1976).

(*) STEPHEN MARGLIN, Department of Economics, Harvard University, Cambridge, Massachusetts 02138 (1976).

(*) HARRY M. MARKOWITZ, General Electric Company, New York, New York (1959).

THOMAS A. MARSCHAK, School of Business Administration, University of California—Berkeley, 350 Barrows Hall, Berkeley, California 94720 (1975).

BELA MARTOS, Institute of Economics, Hungarian Academy of Sciences, Budapest, XI, Budaorsi ut 43-45, Hungary (1982).

MICHAEL MASCHLER, Department of Mathematics, The Hebrew University, Jerusalem 91904, Israel (1989).

ANDREU MAS-COLELL, Department of Economics, Harvard University, Cambridge, Massachusetts 02138 (1977).

ERIC MASKIN, Department of Economics, Harvard University, Cambridge, Massachusetts 02138 (1981).

STEVEN MATTHEWS, Department of Economics, Northwestern University, Evanston, Illinois 60208-2600 (1992).

BENNETT T. MCCALLUM, Graduate School of Industrial Administration, Carnegie-Mellon University, Schenley Park, Pittsburgh, Pennsylvania 15213 (1992).

DANIEL MCFADDEN, Department of Economics, 655 Evans Hall, University of California—Berkeley, Berkeley, CA 94720 (1969).

LIONEL MCKENZIE, Department of Economics, University of Rochester, Rochester, New York 14627 (1958).

JEAN-FRANÇOIS MERTENS, CORE, Université Catholique de Louvain, 34 Voie du Roman Pays, B-1348 Louvain-la-Neuve, Belgium (1981).

ROBERT C. MERTON, Harvard Business School, Soldiers Field/Morgan 397, Boston, Massachusetts 02163 (1983).

JOHN R. MEYER, Harvard University, JFK School of Government, 79 JFK Street, Cambridge, Massachusetts 02138 (1966).

PAUL MILGROM, Department of Economics, Stanford University, Stanford, California 94305-6072 (1983).

(*) MERTON H. MILLER, Graduate School of Business, University of Chicago, 1101 East 58th Street, Chicago, Illinois 60637 (1975).

(*) JEAN-CLAUDE MILLERON, 9 rue JB Lully, 94440 Santeny, France (1978).

JACOB MINCER, Department of Economics, Columbia University, New York, New York 10027 (1972).

BAGICHA SINGH MINHAS, Indian Statistical Unit, Delhi Center, 7, S.J.S., Sansanwal Marg, New Delhi, 110 016 India (1973).

LEONARD J. MIRMAN, James Wilson Department of Economics, Rouss Hall, University of Virginia, Charlottesville, Virginia 22901 (1978).

JAMES MIRRLEES, Nuffield College, Oxford University, Oxford OX1 1NF, England (1970).

FRANCO MODIGLIANI, Alfred P. Sloan School of Management, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1949).

ALAIN MONFORT, Research Department, Institut National de la Statistique et des Etudes Economiques, 18 Boulevard Adolphe Pinard, 75675 Paris, Cedex 14, France (1985).

JOHN MOORE, Department of Economics, London School of Economics, Houghton Street, London WC2A 2AE, England (1989).

(*) CHIKASHI MORIGUCHI, The Institute of Social and Economic Research, Osaka University, 6-1, Mihogaoka, Ibaraki, Osaka 567 Japan (1986).

MICHIO MORISHIMA, Department of Economics, London School of Economics, Houghton Street, Aldwych, London WC2A 2AE, England (1958).

DALE MORTENSEN, Department of Economics, Northwestern University, Evanston, Illinois 60208-2600 (1978).

HERVÉ MOULIN, Department of Economics, Duke University, Durham, North Carolina 27706 (1983).

(*) JOHN MUELLBAUER, Nuffield College, Oxford University, Oxford OX1 1NF, England (1979).

YAIR MUNDLAK, Faculty of Agriculture, The Hebrew University, P.O.B. 12, Revohot, Israel (1970).

(*) MICHAEL L. MUSSA, Research Department, International Monetary Fund, 700 19th Street NW, Washington, D.C. 20431 (1986).

JOHN F. MUTH, Graduate School of Business, Indiana University, Bloomington, Indiana 47401 (1968).

ROGER B. MYERSON, MEDS Department, Kellogg Graduate School of Management, Northwestern University, Evanston, Illinois 60208-2001 (1983).

A. L. NAGAR, Delhi School of Economics, Delhi 110 007, India (1970).

ANDRAS NAGY, Institute of Economics, Hungarian Academy of Sciences, Budaorsi ut 43, 1112 Budapest, XI Hungary (1978).

JOHN F. NASH, JR., 932 Alexander Road, Princeton Junction, New Jersey 08550 (1990).

J. PETER NEARY, Department of Political Economy, University College Dublin, Belfield, Dublin 4, Ireland (1987).

TAKASHI NEGISHI, Faculty of Economics, University of Tokyo, 3-1 Hongo 7-Chome, Bunkyo-Ku, Tokyo 113, Japan (1966).

MARC NERLOVE, Department of Economics, University of Pennsylvania, 3718 Locust Walk, Philadelphia, Pennsylvania 19104-6209 (1960).

D. M. G. NEWBERY, Department of Applied Economics, Sidgwick Avenue, University of Cambridge, Cambridge CB3 9DE, England (1989).

WHITNEY NEWEY, Department of Economics, Massachussetts Institute of Technology, Cambridge, Massachusetts 02139 (1989).

(*) ABRAHAM NEYMAN, Department of Economics, The Hebrew University, Jerusalem 91904, Israel (1989).

STEPHEN J. NICKELL, Institute of Economics and Statistics, Oxford University, Manor Road, Oxford OX1 3UL, England (1980).

HUKUKANE NIKAIDO, 4-23-11 Nakaarai, Tokorozawa, Satama-ken, Japan (1962).

KAZUO NISHIMURA, Institute of Economic Research, Kyoto University, Yoshida-honmachi, Sakyoku, Kyoto 606, Japan (1992).

(*) WILLIAM D. NORDHAUS, Cowles Foundation for Research in Economics, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1984).

WALTER OI, Department of Economics, University of Rochester, Rochester, New York 14627 (1975).

MASAHIRO OKUNO-FUJIWARA, Faculty of Economics, University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, Tokyo 113, Japan (1990).

(*) GUY HENDERSON ORCUTT, Department of Economics, Yale University, New Haven, Connecticut 06520 (1956).

JOSEPH M. OSTROY, Department of Economics, University of California—Los Angeles, 405 Hilgard Avenue, Los Angeles, California 90024 (1984).

A. R. PAGAN, Economics Program, R.S.S.S., Australian National University, P.O. Box 4, Canberra, A.C.T. 2601, Australia (1985).

ARIEL PAKES, Department of Economics, Yale University, P.O. Box 1972, Yale Station, New Haven, Connecticut 06520-1972 (1988).

(*) LUIGI L. PASINETTI, Universita Cattolica, Largo Gemelli 1, 20123, Milano, Italy (1978).

DON PATINKIN, Israel Academy of Science and Humanities, Albert Einstein Square, Talbieh, P.O. Box 4040, Jerusalem, Israel 91040 (1953).

PRASANTA K. PATTANAIK, Department of Economics, University of California at Riverside, Riverside, California 92521 (1978).

DAVID PEARCE, Department of Economics, Yale University, New Haven, Connecticut, 06520 (1991).

(*) IVOR F. PEARCE, The University of Southampton, Southampton S09 5NH, England (1975).

(*) EGON A. PEARSON, The University of London, London WC2A 2AE, England (1948).

BEZALEL PELEG, The Institute of Mathematics, The Hebrew University, Jerusalem, 91904 Israel (1977).

M. HASHEM PESARAN, Department of Economics, University of California—Los Angeles, 405 Hilgard Avenue, Los Angeles, California 90024-1477 (1989).

EDMUND S. PHELPS, Department of Economics, Columbia University, New York, New York 10027 (1967).

PETER C. B. PHILLIPS, Cowles Foundation for Research in Economics, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1981).

Louis Phlips, European University Institute, Department of Economics, Badia Fiesolana, Via dei Roccettini, 9, 1-50016 San Domenico di Fiesole (FI), Italy (1980).

Charles R. Plott, Division of the Humanities and Social Sciences, 228-77, California Institute of Technology, Pasadena, California 91125 (1985).

Jacques J. Polak, International Monetary Fund, 700 19th Street N.W., Washington, D.C. 20431 (1952).

Heraklis M. Polemarchakis, Université Catholique de Louvain, CORE, 34 Voie du Roman Pays, B-1348 Louvain-la-Neuve, Belgium (1991).

Robert A. Pollak, Department of Economics, 3718 Locust Walk, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6297 (1977).

Victor Polterovich, CEMI, USSR Academy of Sciences, Krasikova str. 32, 117418 Moscow, Russia (1989).

Robert Porter, Department of Economics, Northwestern University, 2003 Sheridan Road, Evanston, Illinois 60208-2600 (1989).

Richard D. Portes, Department of Economics, Birkbeck College, 7-15 Gresse Street, London W1P 1PA, England (1983).

(*) Krzysztof Porwit, Central School of Planning and Statistics, Al. Niepodleglosci 162, Warszawa, Poland (1973).

Andrew Postlewaite, Department of Economics, 3718 Locust Walk, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6297 (1985).

James Michael Poterba, Department of Economics, E52-350, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1988).

Alan A. Powell, IMPACT Research Centre, Menzies Building 11th Floor, Monash University, Wellington Road, Clayton, Victoria, 3168 Australia (1988).

James L. Powell, Department of Economics, Princeton University, 207 Fisher Hall, Princeton, New Jersey 08544 (1990).

John W. Pratt, Harvard Business School, Morgan 325, Boston, Massachusetts 02163 (1974).

(*) Andras Prekopa, Technical University of Budapest, 1111 Budapest, Muegyetem RKP 3, Budapest, Hungary (1978).

Edward C. Prescott, Department of Economics, University of Minnesota, Minneapolis, Minnesota 55455 (1980).

F. Graham Pyatt, Department of Economics, University of Warwick, Coventry CV4 7AL, England (1978).

Richard E. Quandt, Department of Economics, Princeton University, Princeton, New Jersey 08540 (1968).

Roy Radner, Bell Laboratories, Room 2C-124, 600 Mountain Avenue, Murray Hill, New Jersey 07974 (1961).

(*) Howard Raiffa, Department of Economics, Harvard University, Cambridge, Massachusetts 02138 (1975).

(*) C. Radhakrishna Rao, Department of Statistics, Pennsylvania State University, 123 Pond Laboratory, University Park, Pennsylvania 16802 (1972).

(*) Olav Reiersol, Minister Ditleffs Vei 20, Oslo 8, Norway (1952).

Jennifer F. Reinganum, Department of Economics, University of Iowa, Iowa City, Iowa 52242 (1989).

Stanley Reiter, Department of Economics, Northwestern University, Evanston, Illinois 60208-2600 (1970).

Jean-François Richard, Economics Department, University of Pittsburgh, Forbes Quad 4517, Pittsburgh, Pennsylvania 15260 (1980).

Marcel K. Richter, Department of Economics, University of Minnesota, Minneapolis, Minnesota 55455 (1974).

John G. Riley, Department of Economics, University of California—Los Angeles, Los Angeles, California 90024 (1983).

D. John Roberts, Graduate School of Business, Stanford University, Stanford, California 94305 (1982).

Kevin W. S. Roberts, Department of Economics, London School of Economics, Houghton Street, London WC2A 2AE, England (1987).

Peter M. Robinson, Department of Economics, London School of Economics, Houghton Street, London WC2A 2AE, England (1989).

John E. Roemer, Department of Economics, University of California—Davis, Davis, California 95616 (1986).

Kenneth S. Rogoff, Department of Economics, University of California—Berkeley, Berkeley, California 94720 (1991).

Richard Roll, Graduate School of Management, University of California—Los Angeles, Los Angeles, California 90024 (1989).

Paul M. Romer, 787 Evans Hall, Department of Economics, University of California—Berkeley, Berkeley, California 94720 (1990).

Harvey S. Rosen, Department of Economics, Princeton University, 113 Dickinson Hall, Princeton, New Jersey 08544 (1986).

Sherwin Rosen, Department of Economics, University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637 (1976).

Robert W. Rosenthal, Department of Economics, Boston University, 270 Bay State Road, Boston, Massachusetts 02215 (1986).

Stephen A. Ross, School of Organization and Management, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1978).

Julio J. Rotemberg, Sloan School of Management, Massachusetts Institute of Technology, 50 Memorial Drive, Cambridge, Massachusetts 02139 (1990).

Alvin E. Roth, Department of Economics, University of Pittsburgh, Pittsburgh, Pennsylvania 15260 (1983).

Thomas J. Rothenberg, Department of Economics, University of California—Berkeley, Berkeley, California 94720 (1977).

Michael Rothschild, Department of Economics D-008, University of California—San Diego, La Jolla, California 92093 (1974).

Ariel Rubinstein, Department of Economics, Tel Aviv University, Ramat Aviv 69978, Israel (1985).

(*) Richard Ruggles, Department of Economics, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1955).

Jeffrey D. Sachs, Department of Economics, Harvard University, Cambridge, Massachusetts 02138 (1986).

(*) Wieslaw Sadowski, Institute of Planning, Warszawa, Poland (1970).

Paul A. Samuelson, Department of Economics, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1944).

(*) Jan Sandee, Pellenaerstraat 27, The Hague, The Netherlands (1965).

Agnar Sandmo, Department of Economics, Norges Handelshoyskole, 5035 Bergen-Sandviken, Norway (1976).

John D. Sargan, 49, Dukes Avenue, Theydon Bois, Epping, Essex CM16 7HQ, England (1963).

(*) Thomas J. Sargent, Hoover Institution, Stanford University, Stanford, California 94305-6010 (1976).

Mark A. Satterthwaite, M.E.D.S., Kellogg Graduate School of Management, Northwestern University, Evanston, Illinois 60208-2001 (1986).

N. Eugene Savin, Department of Economics, University of Iowa, Iowa City, Iowa 52242 (1985).

Takamitsu Sawa, Kyoto Institute of Economic Research, Kyoto University, Sakyoku, Kyoto 606, Japan (1978).

Herbert Scarf, Cowles Foundation for Research in Economics, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1962).

José Alexandre Scheinkman, Department of Economics, University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637 (1978).

Richard Schmalensee, Massachusetts Institute of Technology, Room E52-456, 50 Memorial Drive, Cambridge, Massachusetts 02139 (1982).

(*) David Schmeidler, School of Mathematical Sciences, Tel-Aviv University, Ramat Aviv 69978, Tel-Aviv, Israel (1980).

Peter Schmidt, Department of Economics, Marshall Hall, Michigan State University, East Lansing, Michigan 48824-1038 (1988).

Peter Schoenfeld, Am Kreizekranz 7, D-5340 Bad Honnef 1, Germany (1976).

Myron S. Scholes, Graduate School of Business, Stanford University, Stanford, California 94305 (1984).

Reinhard Selten, Department of Economics, University of Bonn, Adenauerallee 24-42, D-5300 Bonn 1, Germany (1973).

Amartya K. Sen, Department of Economics, Littauer Center, Harvard University, Cambridge, Massachusetts 02138 (1968).

(*) G. L. S. Shackle, Rudloe, Aldehouse Drive, Aldeburgh, Suffolk 1P15 5EE, England (1959).

Avner Shaked, Department of Economics, University of Bonn, Adenauerallee 24, D-5300 Bonn 1, Germany (1991).

Lloyd S. Shapley, Department of Economics, University of California—Los Angeles, Los Angeles, California 90024 (1967).

(*) Steven Shavell, Harvard Law School, Langdell Hall 357, 1545 Massachusetts Avenue, Cambridge, Massachusetts 02138 (1988).

Karl Shell, Department of Economics, Cornell University, Ithaca, New York 14853-7601 (1973).

Eytan Sheshinski, Department of Economics, The Hebrew University, Jerusalem, Israel 91905 (1971).

Robert J. Shiller, Department of Economics, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1980).

(*) John B. Shoven, Department of Economics, Stanford University, 4th Floor Encina Hall, Stanford, California 94305 (1984).

Martin Shubik, Department of Economics, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1970).

Joaquim Silvestre, Department of Economics, University of California, Davis, Davis, California 95616 (1991).

Herbert A. Simon, Department of Psychology, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213 (1954).

Christopher Sims, Department of Economics, 37 Hillhouse Avenue, Yale University, New Haven, Connecticut 06520-1962 (1974).

Kenneth J. Singleton, Graduate School of Business, Stanford University, Palo Alto, California 94305 (1988).

Stephen Smale, Department of Mathematics, University of California—Berkeley, Berkeley, California 94720 (1982).

Vernon L. Smith, Department of Economics, University of Arizona, Tucson, Arizona 85721 (1987).

Joel Sobel, Department of Economics, D-008, University of California—San Diego, La Jolla, California 92093 (1990).

(*) Robert Solow, Department of Economics, E52-383, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1957).

Dieter Sondermann, University of Bonn, Adenauerallee 24-42, 5300 Bonn, Germany (1977).

Hugo Sonnenschein, Office of the President, 5801 S. Ellis Ave., University of Chicago, Chicago, Illinois 60637 (1973).

(*) A. MICHAEL SPENCE, Dean, Stanford Business School, Stanford University, Palo Alto, California 94304 (1976).

T. N. SRINIVASAN, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1970).

DAVID STARRETT, Department of Economics, Stanford University, Stanford, California 94305 (1975).

NICHOLAS H. STERN, London School of Economics, 404 Lionel Robbins Building, Rm. R, Houghton Street, London WC2A 2AE, England (1978).

JOSEPH E. STIGLITZ, Department of Economics, Stanford University, Stanford, California 94305 (1973).

JAMES H. STOCK, John F. Kennedy School of Government, 79 John F. Kennedy Street, Harvard University, Cambridge, Massachusetts 02138 (1992).

THOMAS M. STOKER, Sloan School of Management, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 (1991).

NANCY L. STOKEY, Department of Economics, University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637 (1987).

(*) SIR J. RICHARD STONE, 13 Millington Road, Cambridge CB3 9HW, England (1945).

(*) ROBERT H. STROTZ, Crown 2-130, Northwestern University, Evanston, Illinois 60208-2600 (1959).

(*) DANIEL B. SUITS, Department of Economics, Michigan State University, East Lansing, Michigan 48823 (1966).

LAWRENCE H. SUMMERS, Vice President and Chief Economist, The World Bank, Room S-9035, 1818 H Street NW, Washington, D.C. 20433 (1985).

ROBERT SUMMERS, Department of Economics, 3718 Locust Walk, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6297 (1989).

JOHN SUTTON, Department of Economics, London School of Economics, Houghton Street, London WC2A 2AE, England (1991).

KOTARO SUZUMURA, The Institute of Economic Research, Hitotsubashi University, Naka 2-1, Kunitachi, Tokyo, Japan (1990).

LARS E. O. SVENSSON, Institute for International Economic Studies, University of Stockholm, S-10691 Stockholm, Sweden (1990).

PAUL TAUBMAN, Department of Economics, University of Pennsylvania, Philadelphia, Pennsylvania 19104 (1977).

JOHN B. TAYLOR, Department of Economics, Encina Hall, Stanford University, Stanford, California 94305-6072 (1984).

LESTER G. TELSER, Department of Economics, University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637 (1968).

HENRY THEIL, Graduate School of Business, University of Florida, Gainesville, Florida 32611 (1955).

JACQUES-FRANÇOIS THISSE, CORE, 34 Voie du Roman Pays, 1348 Louvain-la-Neuve, Belgium (1992).

WILLIAM THOMSON, Department of Economics, University of Rochester, Rochester, New York 14627 (1990).

J. TINBERGEN, Haviklaan 31, 2566 XD Hague, The Netherlands (1933).

JEAN TIROLE, Institut D'Economie Industrielle, Université des Sciences Sociales de Toulouse, Place Anatole France, F-31042 Toulouse Cedex, France (1986).

JAMES TOBIN, Cowles Foundation for Research in Economics, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1952).

ROBERT M. TOWNSEND, Department of Economics, University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637 (1985).

WITOLD TRZECIAKOWSKI, Langiewicza 2, 02-071 Warszawa, Poland (1978).

STEPHEN J. TURNOVSKY, Department of Economics, University of Washington, 301 Savery Hall, Mail Stop DK 30, Seattle, Washington 98195 (1981).

(*) HIROFUMI UZAWA, Department of Economics, 3-1 Hongo 7 Chome, Bunkyo-ku, University of Tokyo, Tokyo 113, Japan (1960).

HAL R. VARIAN, Department of Economics, University of Michigan, Ann Arbor, Michigan 48109 (1983).

(*) M. J. VERHULST, 180 Rue de Roubaix, Toufflers 59390 France (1957).

WILLIAM VICKREY, 162 Warburton Avenue, Hastings-on-Hudson, New York 10706 (1967).

KARL VIND, University of Copenhagen, Studiestraede 6, Copenhagen DK 1455, Denmark (1973).

XAVIER VIVES, Institut d'Anàlisi Econòmica CSIC, Universidad Autònoma de Barcelona, 08193 Bellaterra, Barcelona, Spain (1992).

JEAN WAELBROECK, Free University of Brussels, 12, Avenue de l'Oree, 1050 Brussels, Belgium (1970).

NEIL WALLACE, Department of Economics, 271 19th Avenue S, University of Minnesota, Minneapolis, Minnesota 55455 (1981).

KENNETH WALLIS, Department of Economics, University of Warwick, Coventy CV4 7AL, England (1975).

(*) SIR ALAN WALTERS, Department of Political Economy, Johns Hopkins University, Baltimore, Maryland 21218 (1970).

MARK W. WATSON, Department of Economics, Northwestern University, Evanston, Illinois 60208-2600 (1992).

HAROLD W. WATTS, Department of Economics, Columbia University, New York, New York 10027 (1976).

ANDREW WEISS, Department of Economics, Boston University, 270 Bay State Road, Boston, Massachusetts 02215 (1989).

MARTIN L. WEITZMAN, Department of Economics, Harvard University, Cambridge, Massachusetts 02138 (1976).

C. CHRISTIAN VON WEIZSACKER, Department of Economics, Universität Köln, Albertus Magnus Platz, D-5000 Koln 41, Germany (1968).

FINIS WELCH, UNICO Research Co., 1640 5th Street, Santa Monica, California 90401 (1980).

JOHN WHALLEY, Department of Economics, University of Western Ontario, London, Ontario, N6A 5C2, Canada (1990).

HALBERT L. WHITE JR., Department of Economics, D-008, University of California—San Diego, La Jolla, California 92093 (1983).

(*) T. M. WHITIN, Department of Economics, Wesleyan University, Middletown, Connecticut 06457 (1958).

(*) OLIVER E. WILLIAMSON, Department of Economics, Yale University, Box 2125 Yale Station, New Haven, Connecticut 06520 (1976).

ROBERT D. WILLIG, Woodrow Wilson School, Princeton University, Princeton, New Jersey 08544 (1981).

CHARLES A. WILSON, Department of Economics, New York University, 269 Mercer Street, New York, New York 10003 (1982).

ROBERT B. WILSON, Graduate School of Business, Stanford University, Stanford, California 94305-5015 (1976).

SIDNEY G. WINTER, Yale School of Organization and Management, Box 1A, Yale University, New Haven, Connecticut 06520 (1978).

DAVID A. WISE, John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts 02138 (1986).

(*) HERMAN O. A. WOLD, Statistiska Institutionen, Uppsala Universitet, Box 513, 751 20 Uppsala, Sweden (1946).

(*) PHILIP WOLFE, 33-221 IBM Research Center, P.O. Box 218, Yorktown Heights, New York 10598 (1979).

P. de Wolff, Cesar Francklaan 4, 2102 EC Heemstede, The Netherlands (1956).

Asher Wolinsky, Department of Economics, Northwestern University, 2003 Sheridan Road, Evanston, Illinois 60208-2600 (1991).

Michael Woodford, Department of Economics, University of Chicago, 1126 East 59th Street, Chicago, Illinois 60637 (1991).

Alan Woodland, Department of Econometrics, University of Sydney, Sydney, N.S.W. 2006, Australia (1988).

Menahem E. Yaari, Department of Economics, The Hebrew University, Jerusalem, Israel (1970).

(*) Yves Younès, CEPREMAP, 142 rue du Chevaleret, 75013 Paris, France (1978).

Shmuel Zamir, Department of Statistics, The Hebrew University, Jerusalem 91905, Israel (1992).

Richard J. Zeckhauser, John F. Kennedy School of Government, 79 John F. Kennedy Street, Harvard University, Cambridge, Massachusetts 02138 (1989).

Arnold Zellner, Graduate School of Business, University of Chicago, Chicago, Illinois 60637 (1965).